

# Probabilistic Asteroid Impact Risk Assessment for the Hypothetical PDC17 Impact Exercise

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Engineering Risk Assessment Team  
NASA Ames Research Center

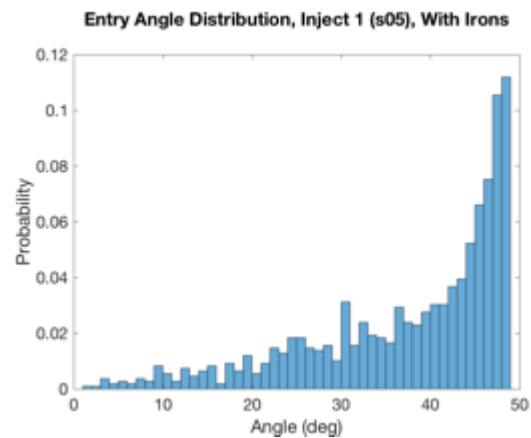
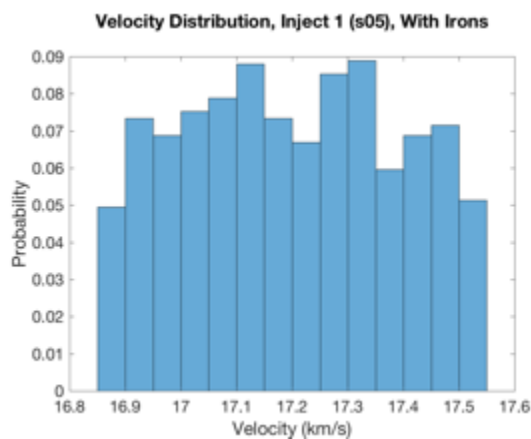
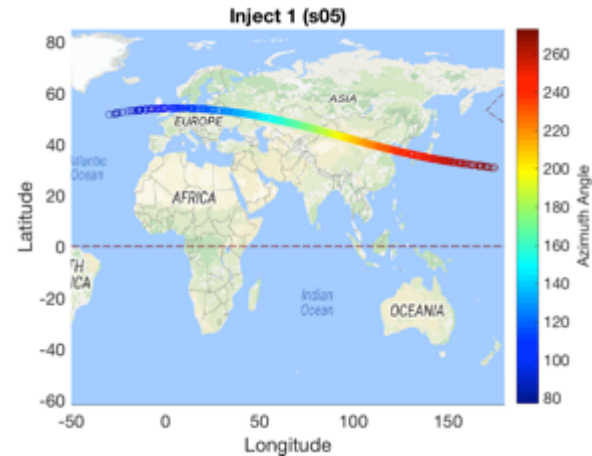
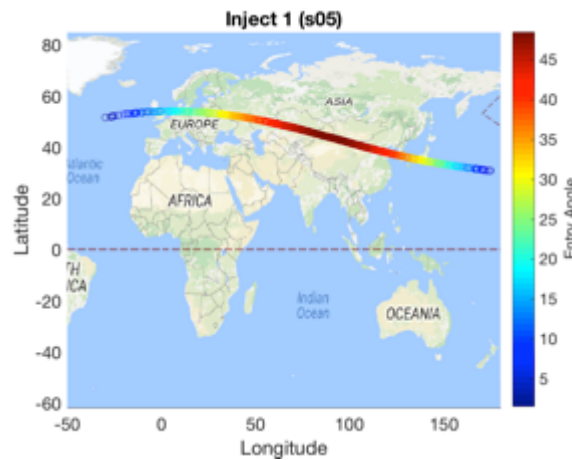
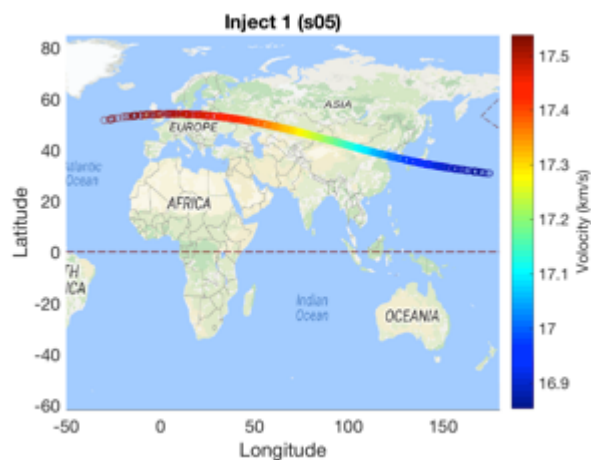
Planetary Defense Conference  
May 15-19, 2017 – Tokyo, Japan



- Performing impact risk assessment for the 2017 Planetary Defense Conference (PDC17) hypothetical impact exercise, to take place at the PDC17 conference, May 15-20, 2017.
  - Impact scenarios and trajectories are developed and provided by NASA's Near Earth Objects Office at JPL (Paul Chodas).
  - These results represent purely hypothetical impact scenarios, and do not reflect any known asteroid threat.
- Risk assessment was performed using the Probabilistic Asteroid Impact Risk (PAIR) model developed by the Asteroid Threat Assessment Project (ATAP) at NASA Ames Research Center.
- This presentation includes sample results that may be presented or used in discussions during the various stages of the impact exercise
  - Some cases represent alternate scenario options that may not be used during the actual impact exercise at the PDC17 conference.
  - Updates to these initial assessments and/or additional scenario assessments may be performed throughout the impact exercise as different scenario options unfold.

# INJECT 1 (S05): MAY 15, 2017

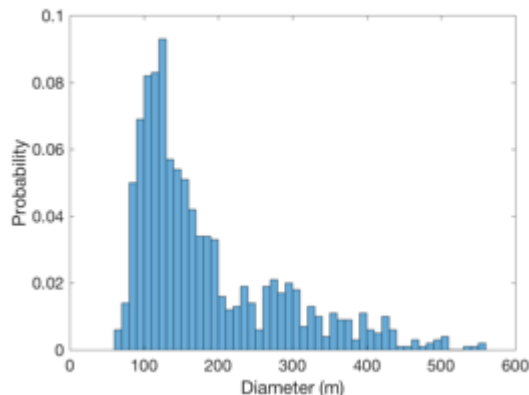
# Swath Trajectory Parameters



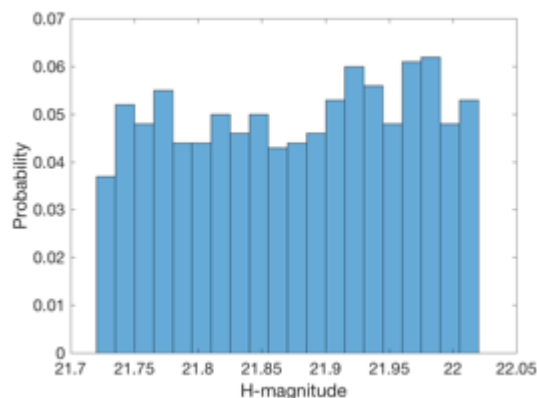


# Asteroid Parameter Distributions

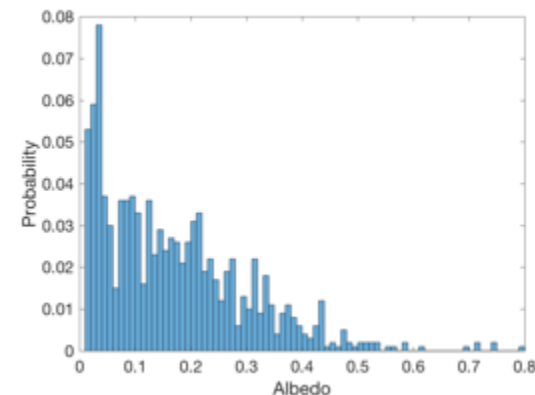
Diameter Distribution, Inject 1 (s05)



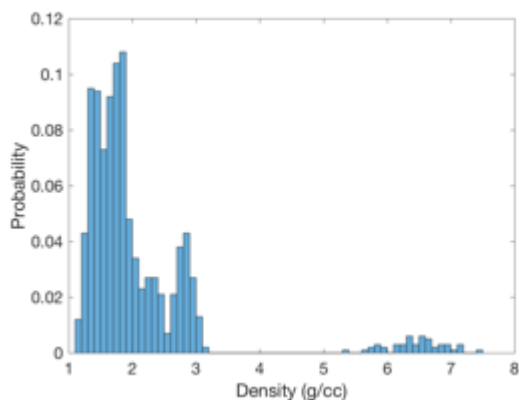
H-mag Distribution, Inject 1 (s05)



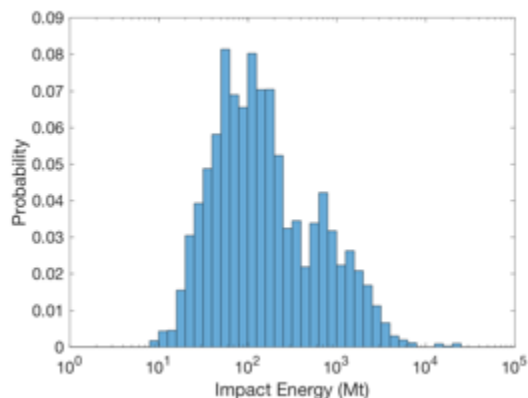
Albedo Distribution, Inject 1 (s05)



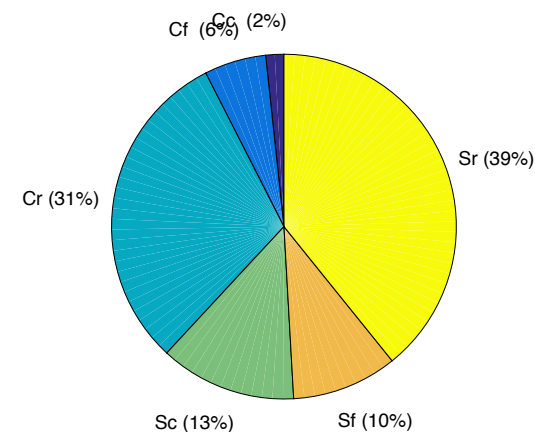
Density Distribution, Inject 1 (s05)



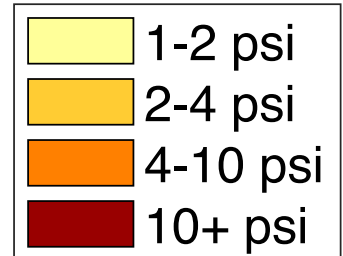
Impact Energy Distribution, Inject 1 (s05)



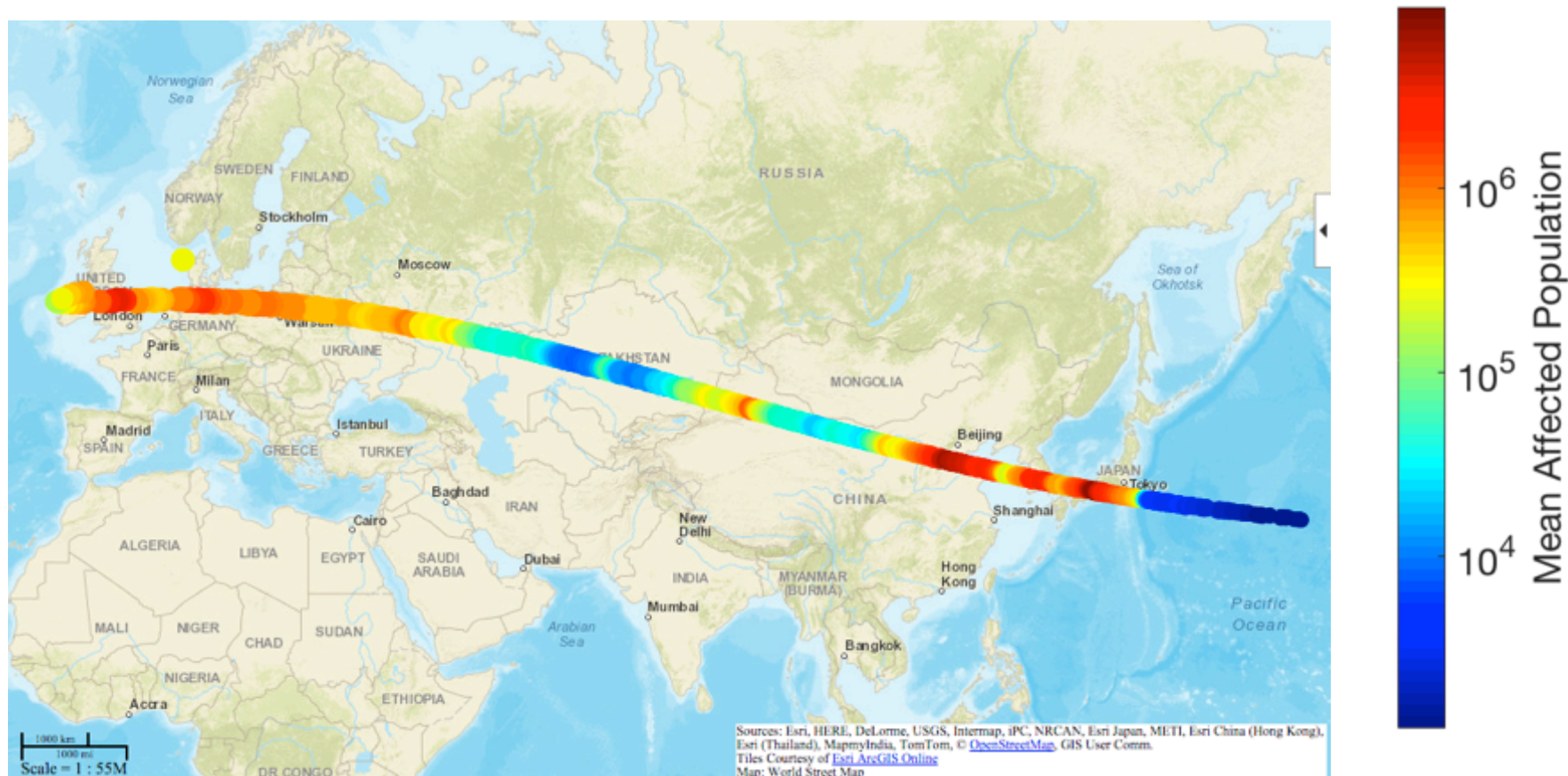
Class & Structure Distribution



# Blast Damage Zones



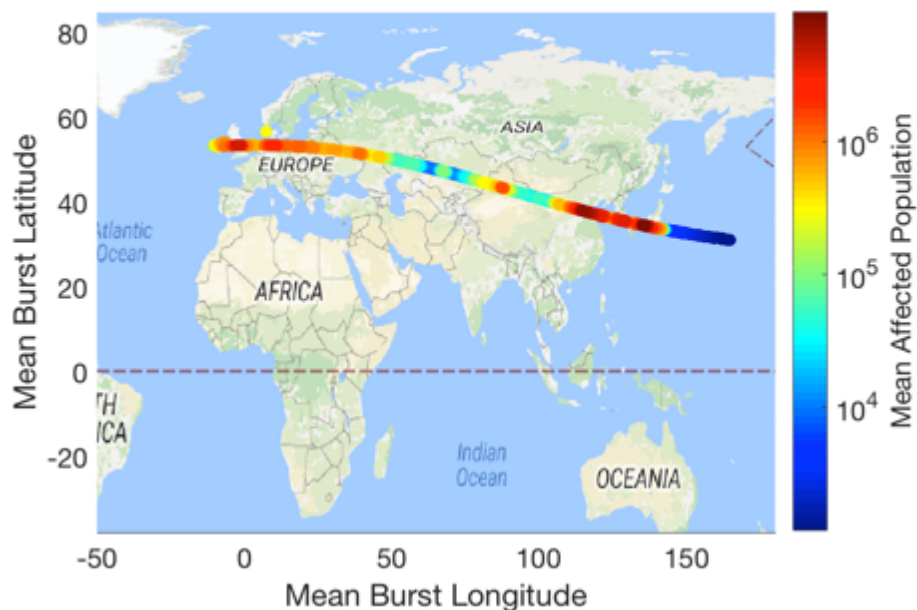
# Mean Affected Population



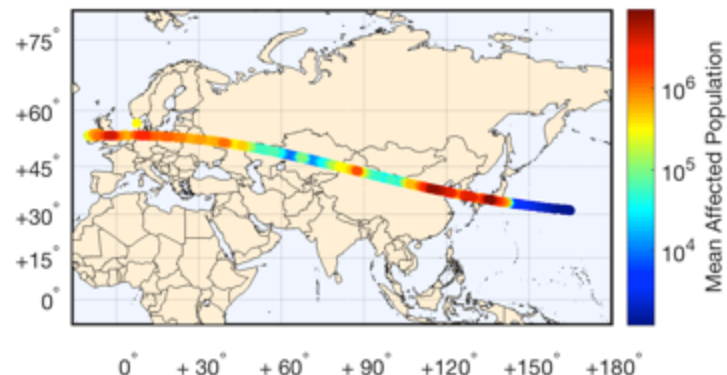


# Mean Affected Population

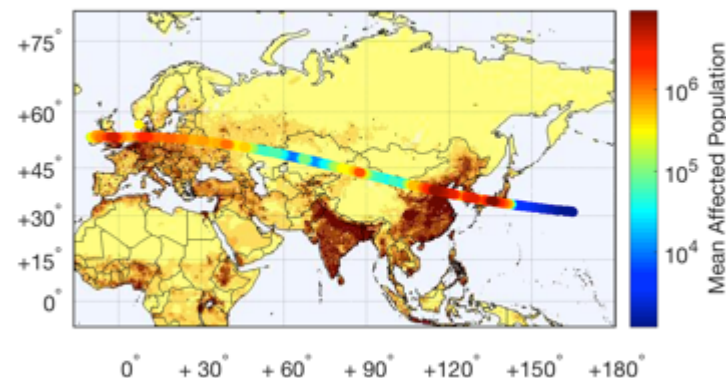
Mean Damage Along Swath  
PDC17 5/15/2017



Mean Damage Along Swath  
PDC17 5/15/2017

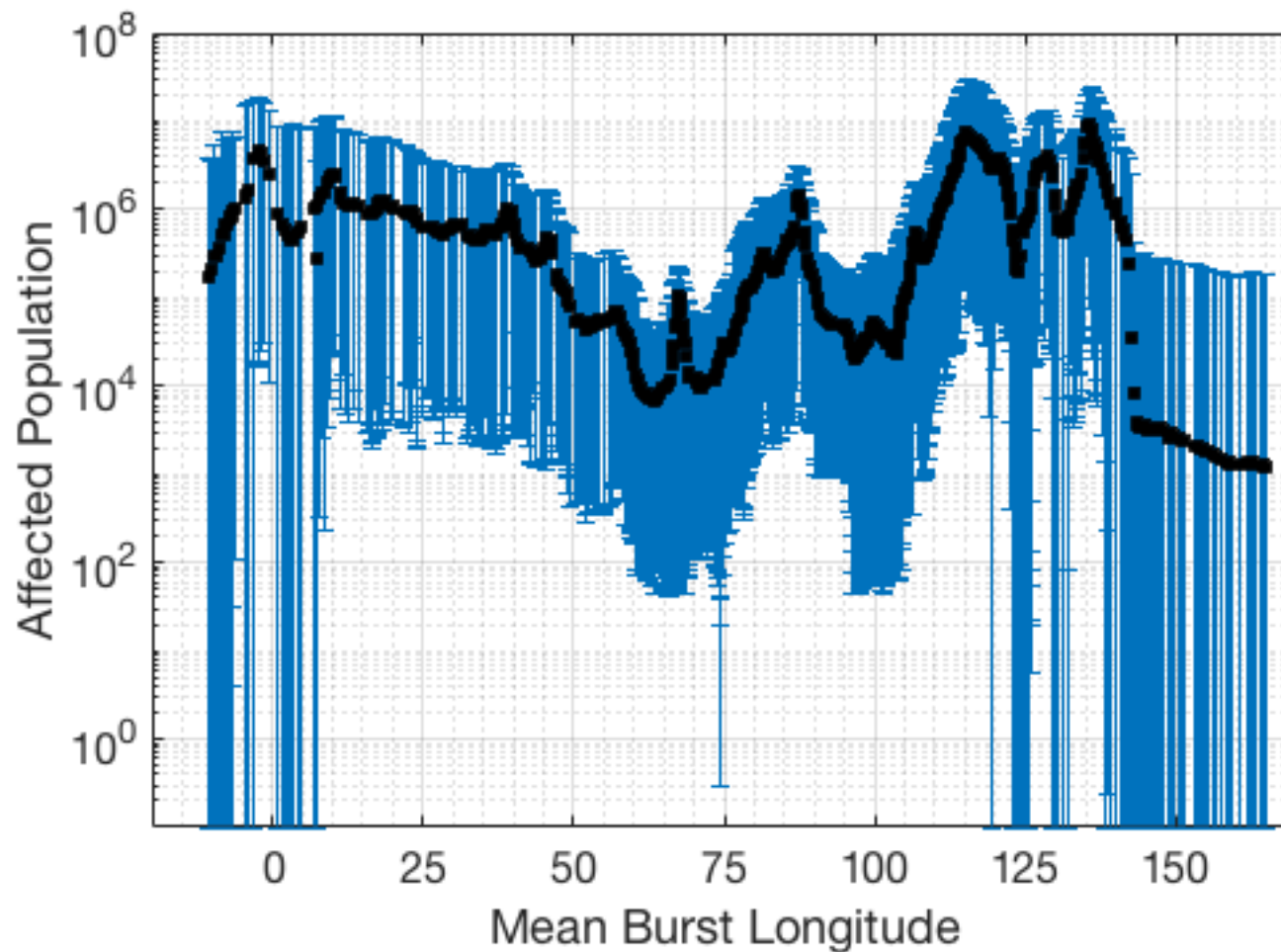


Mean Damage Along Swath  
PDC17 5/15/2017



# Damage Ranges (min/mean/max)

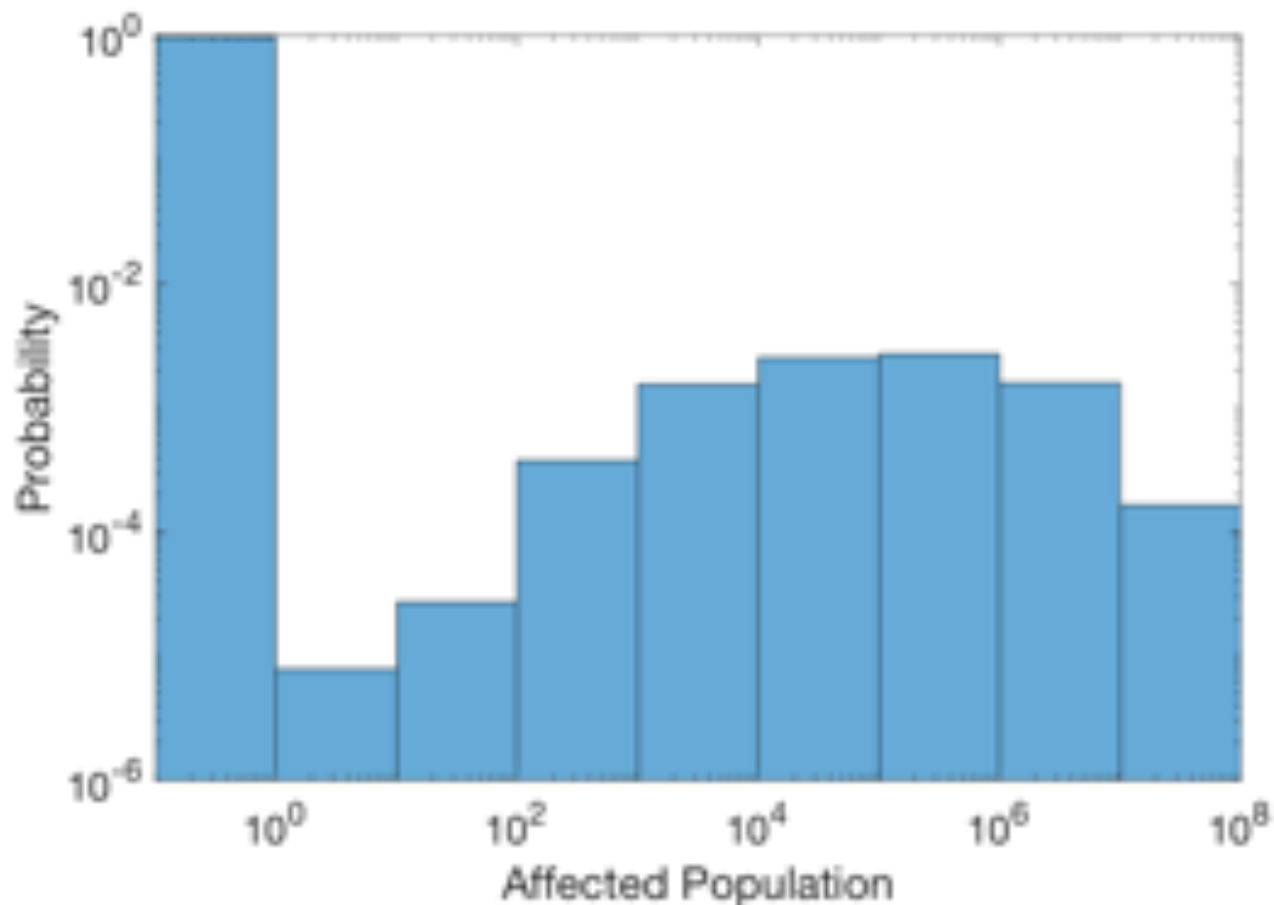
Damage Ranges Along Swath  
PDC17 5/15/2017





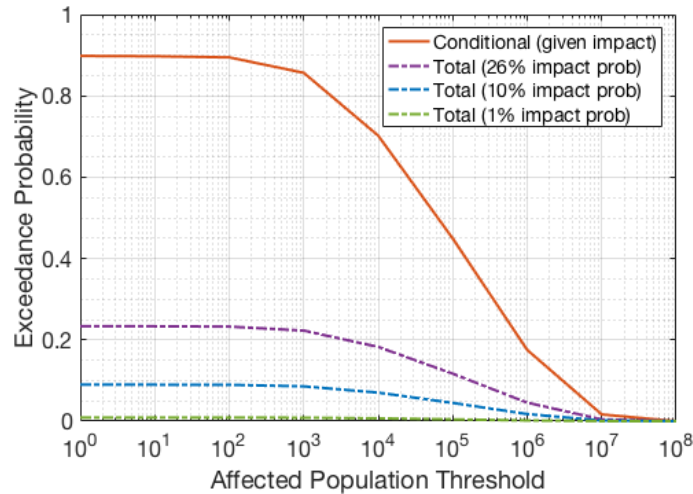
# Damage Level Probabilities

**Total Impact Damage Risk**  
**PDC17 5/15/2017, 1% Impact Probability**



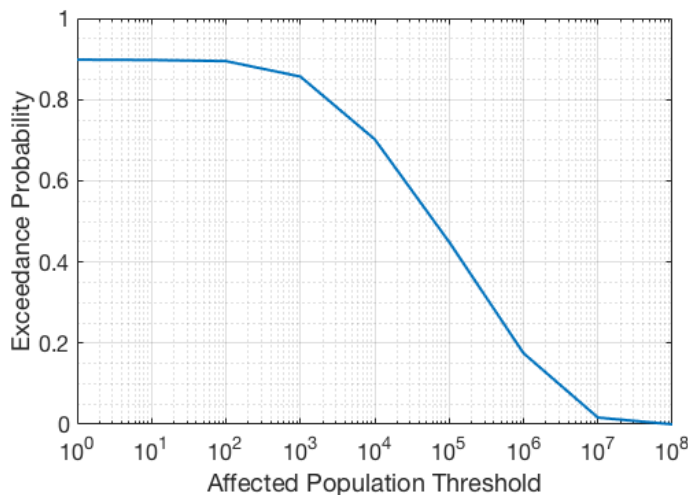
# Damage Exceedance Risk

Damage Exceedance Probabilities  
PDC17 5/15/2017

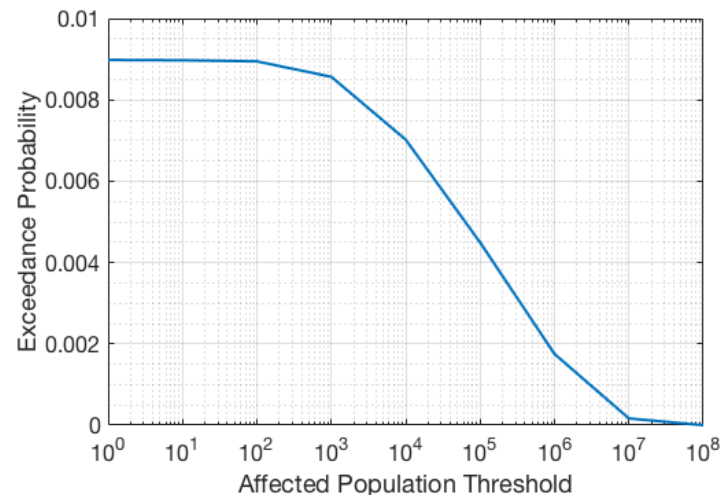


- Probability of an impact causing at least a given damage level or greater.
- Complementary cumulative distribution function (CCDF)

Conditional Damage Exceedance Probabilities  
PDC17 5/15/2017

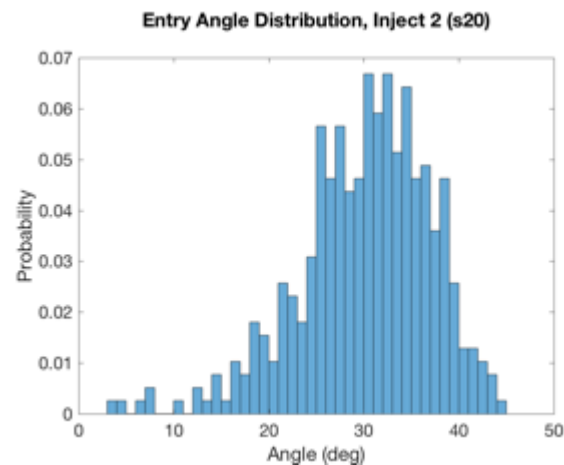
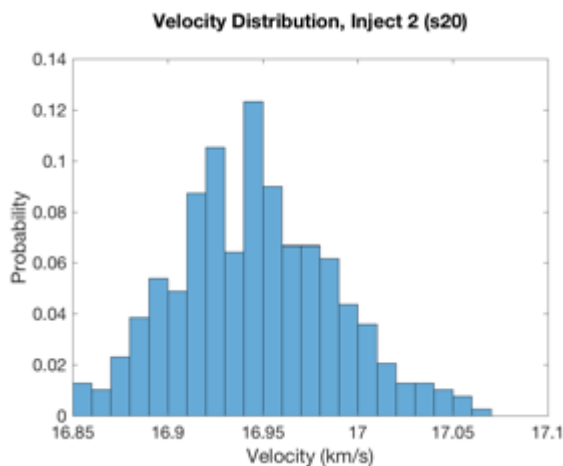
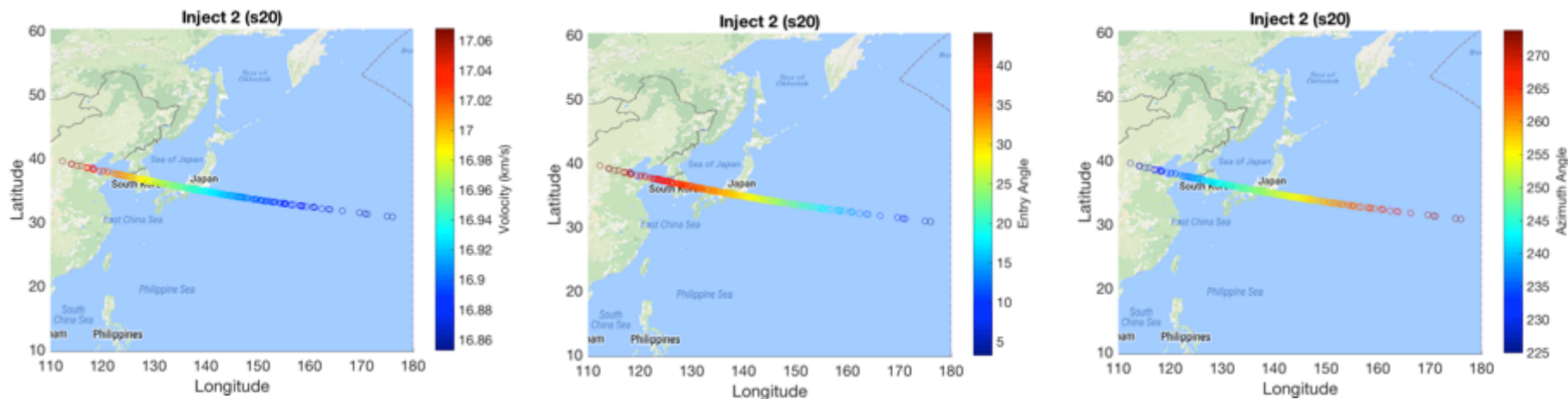


Damage Exceedance Probabilities  
PDC17 5/15/2017, 1% Impact Probability



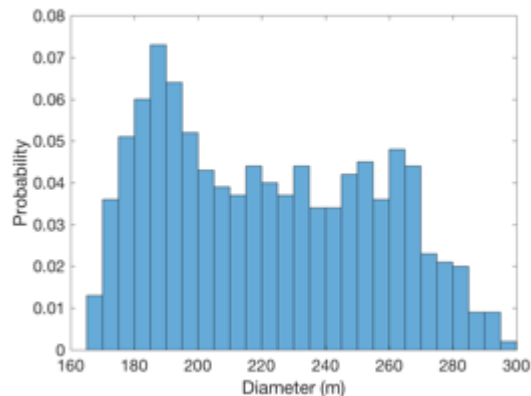
# INJECT 2 S20: NOV 30, 2018

# Swath Trajectory Parameters

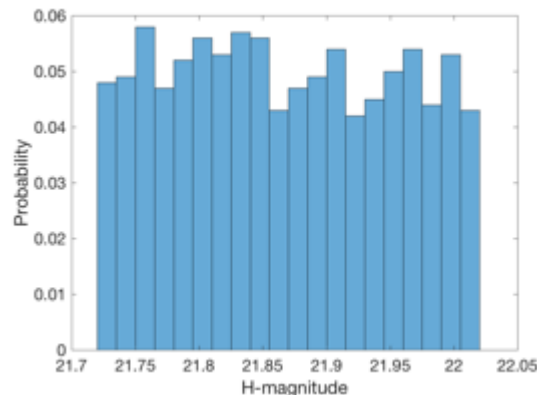


# Asteroid Parameter Distributions (1k realizations)

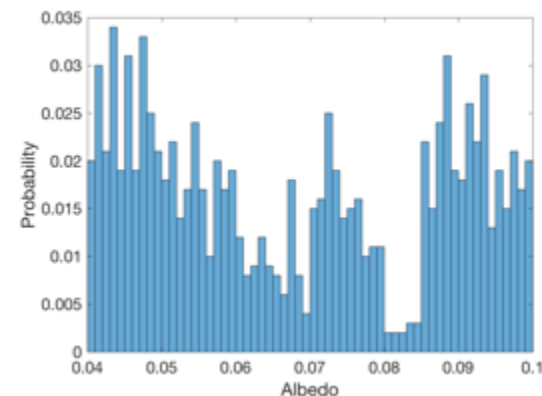
Diameter Distribution, Inject 2 (s20)



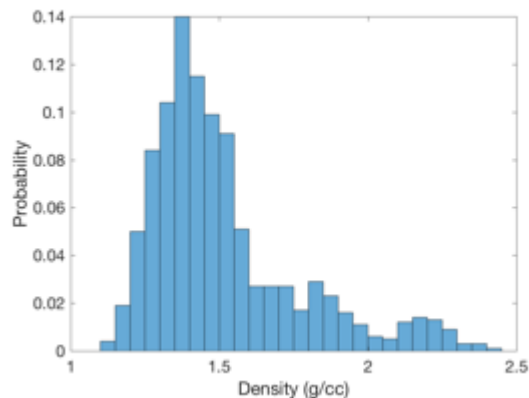
H-mag Distribution, Inject 2 (s20)



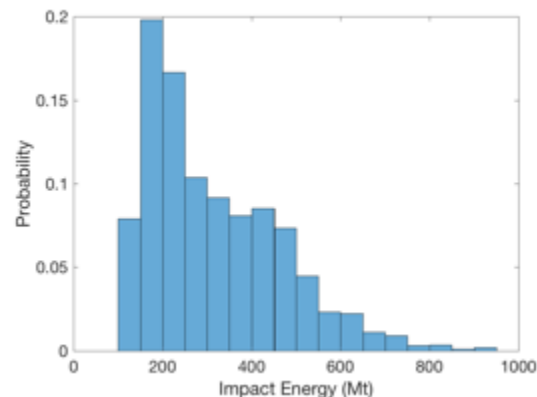
Albedo Distribution, Inject 2 (s20)



Density Distribution, Inject 2 (s20)

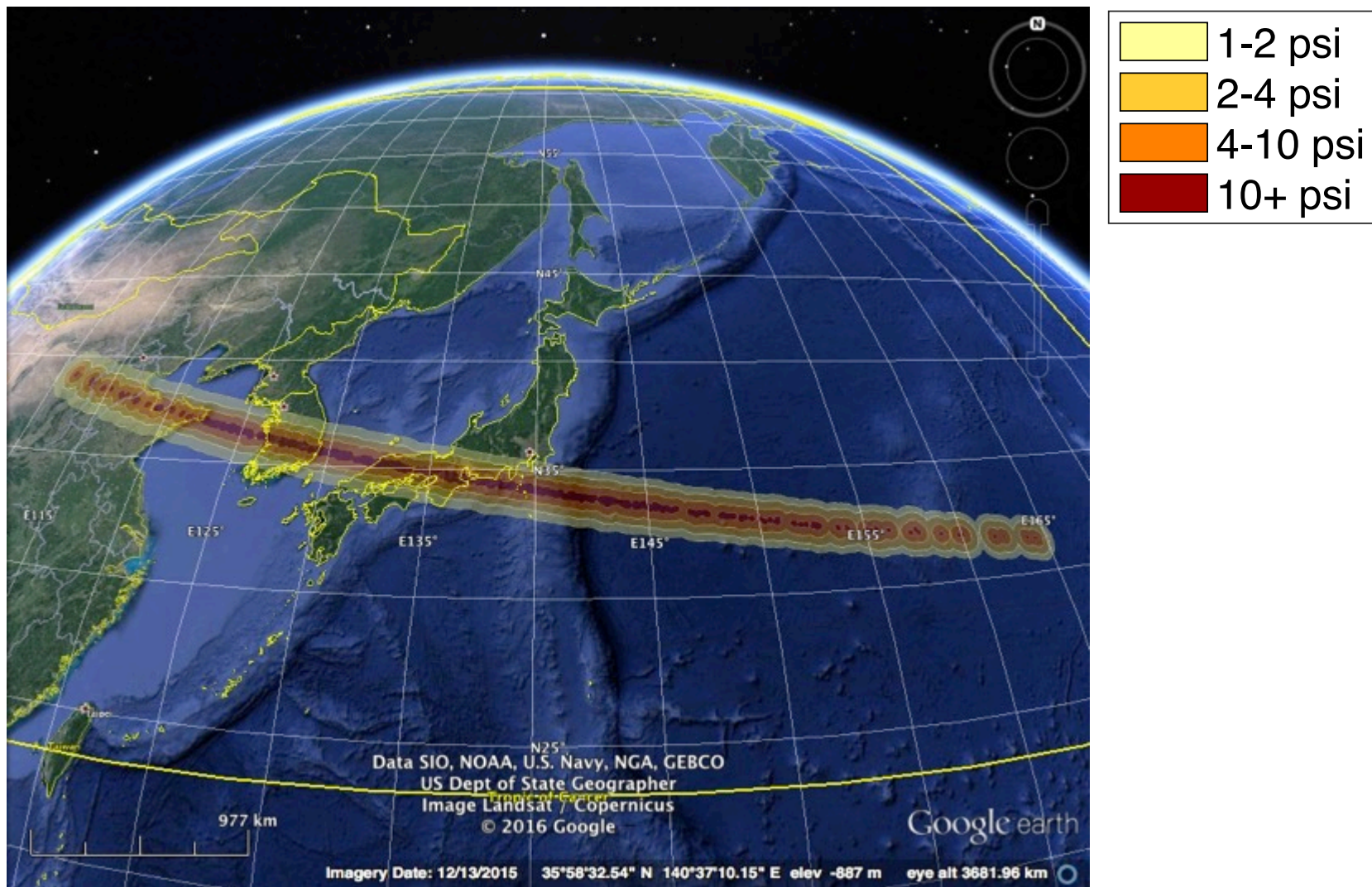


Impact Energy Distribution, Inject 2 (s20)

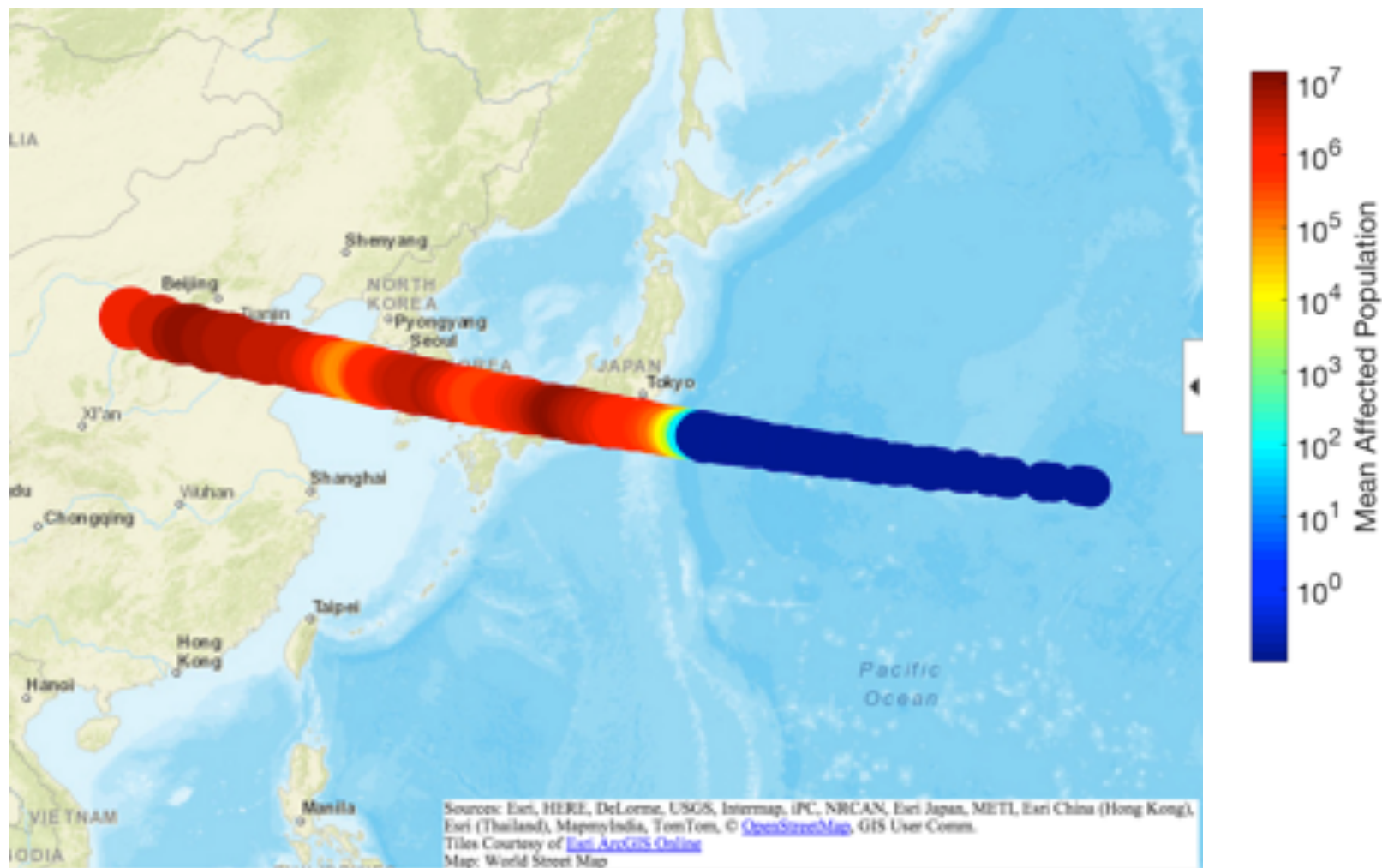




# Blast Damage Zones

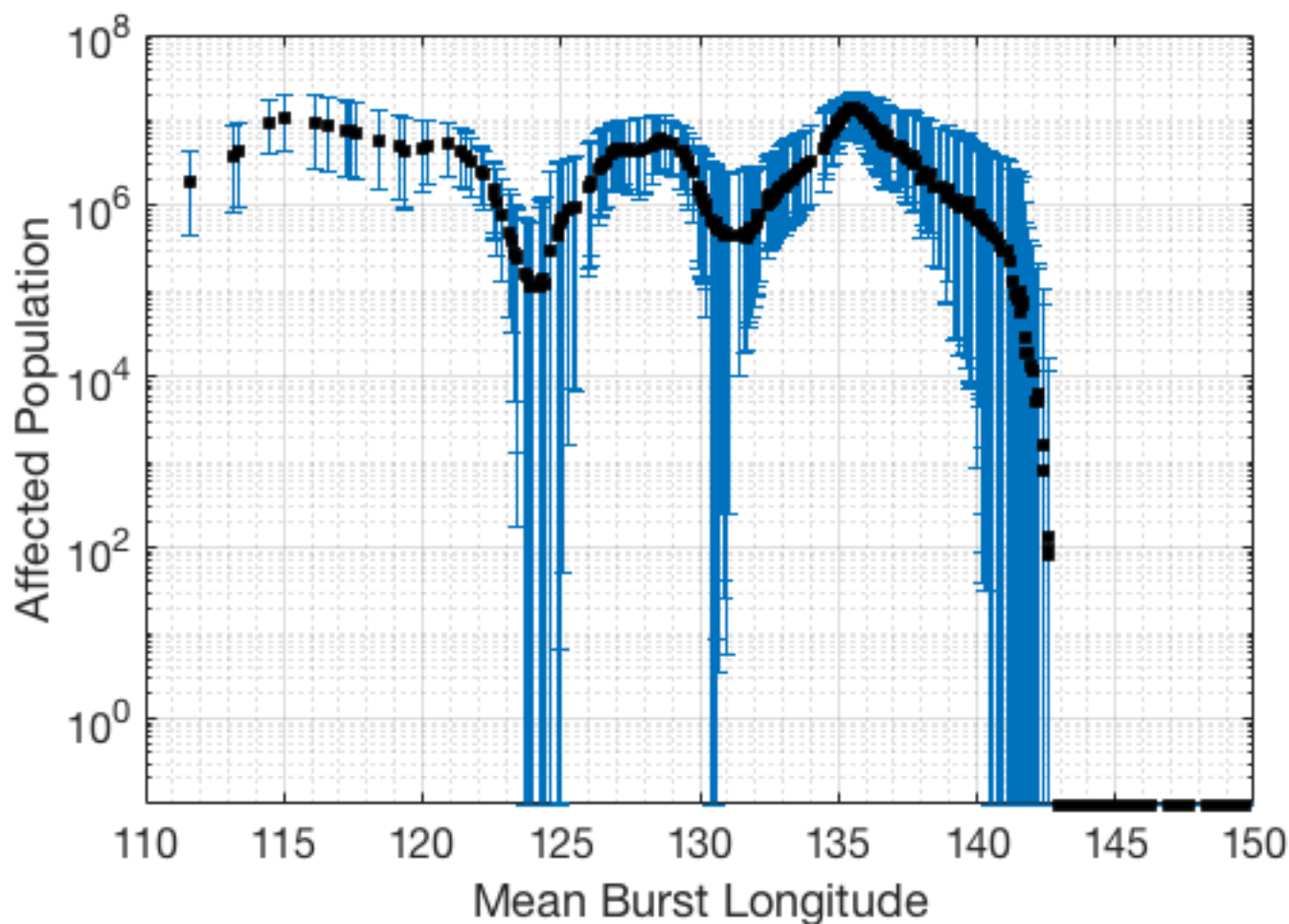


# Mean Affected Population



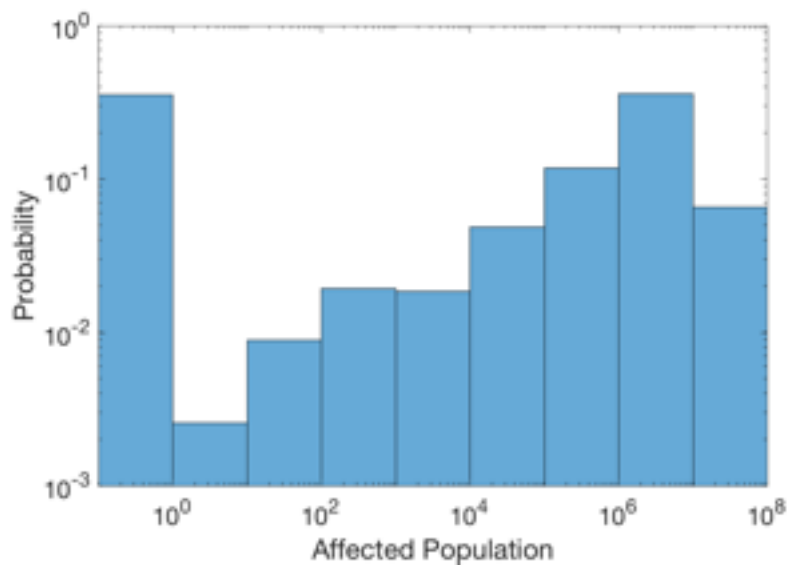
# Damage Ranges (min/mean/max)

Damage Ranges Along Swath  
PDC17 11/30/2018

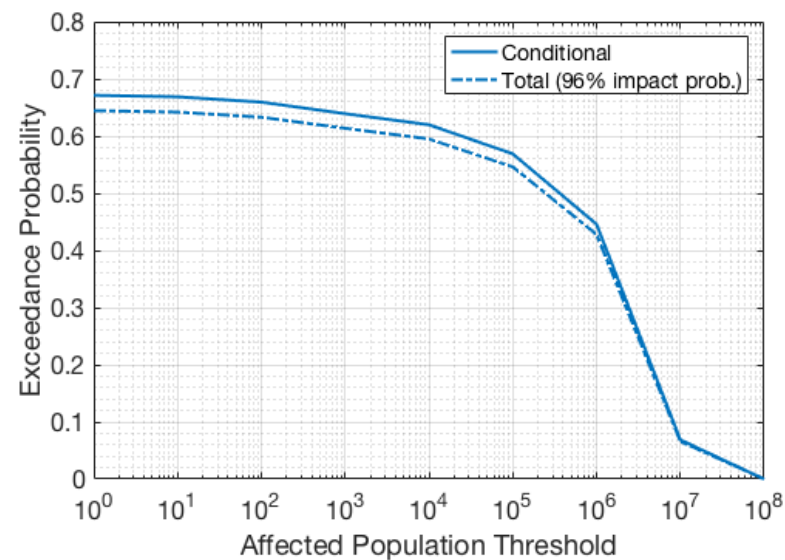


# Damage Level Probabilities

**Total Impact Damage Risk**  
PDC17 11/30/2018, 96% Impact Probability



**Damage Exceedance Probabilities**  
PDC17 11/30/2018

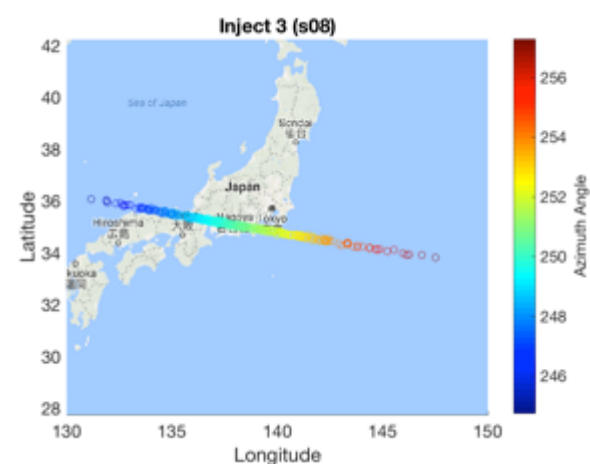
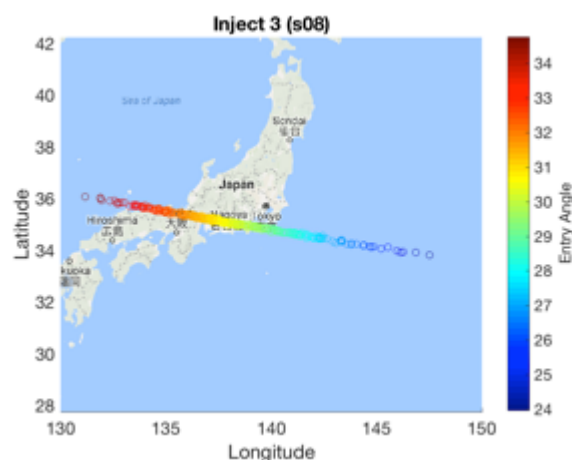
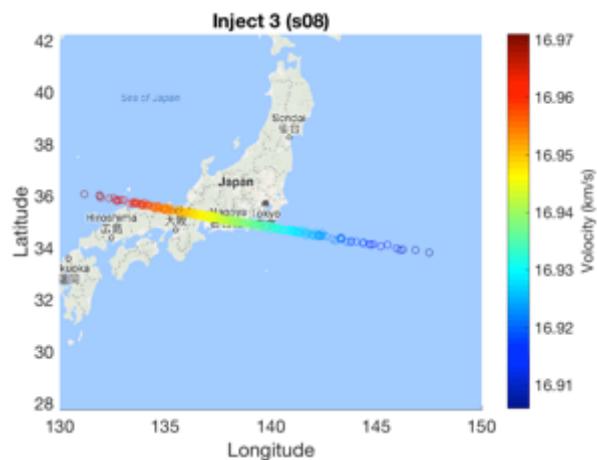




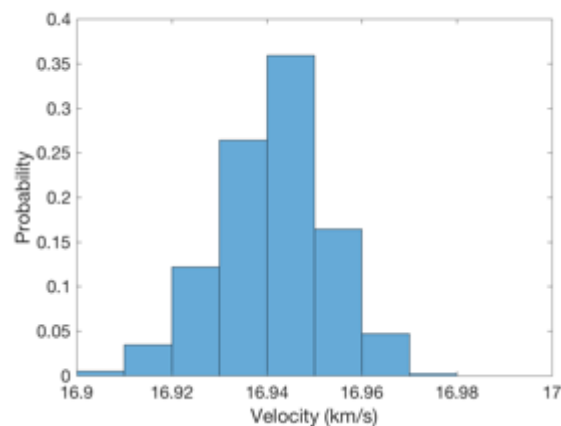
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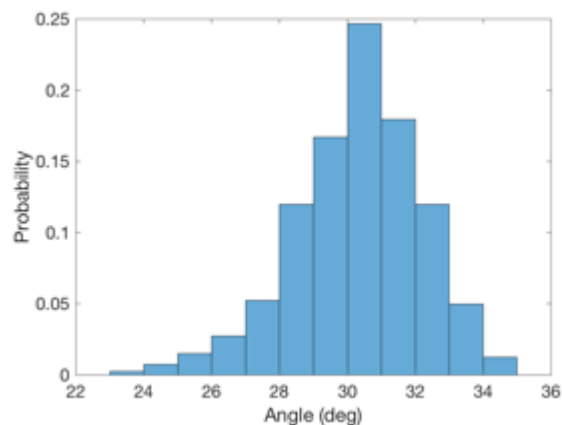
# Swath Trajectory Parameters



**Velocity Distribution, Inject 3 (s08)**

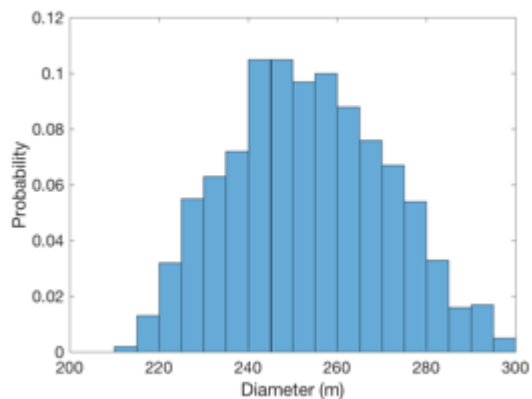


**Entry Angle Distribution, Inject 3 (s08)**

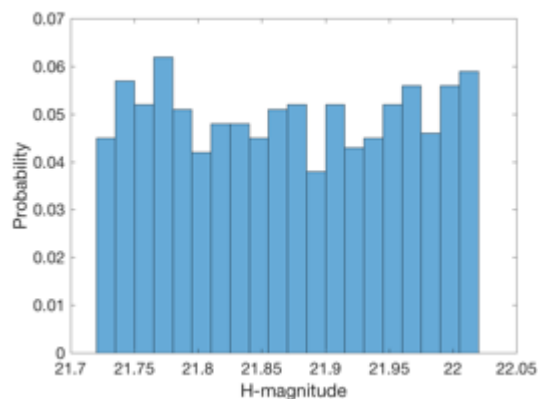


# Parameter Distributions

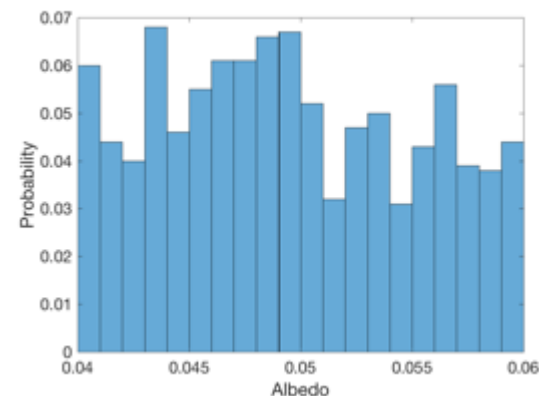
**Diameter Distribution, Inject 3 (s08)**



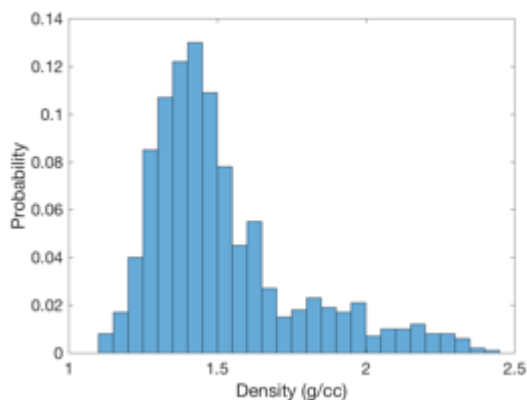
**H-mag Distribution, Inject 3 (s08)**



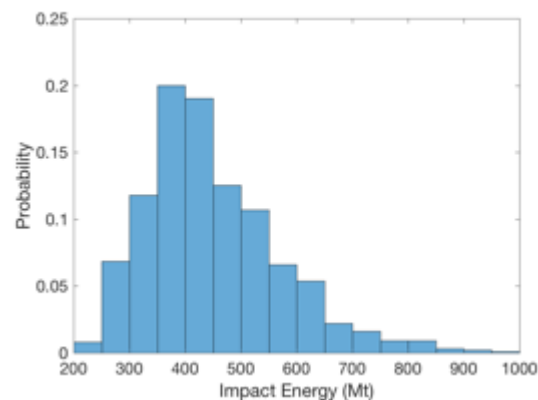
**Albedo Distribution, Inject 3 (s08)**



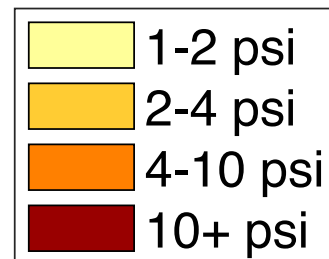
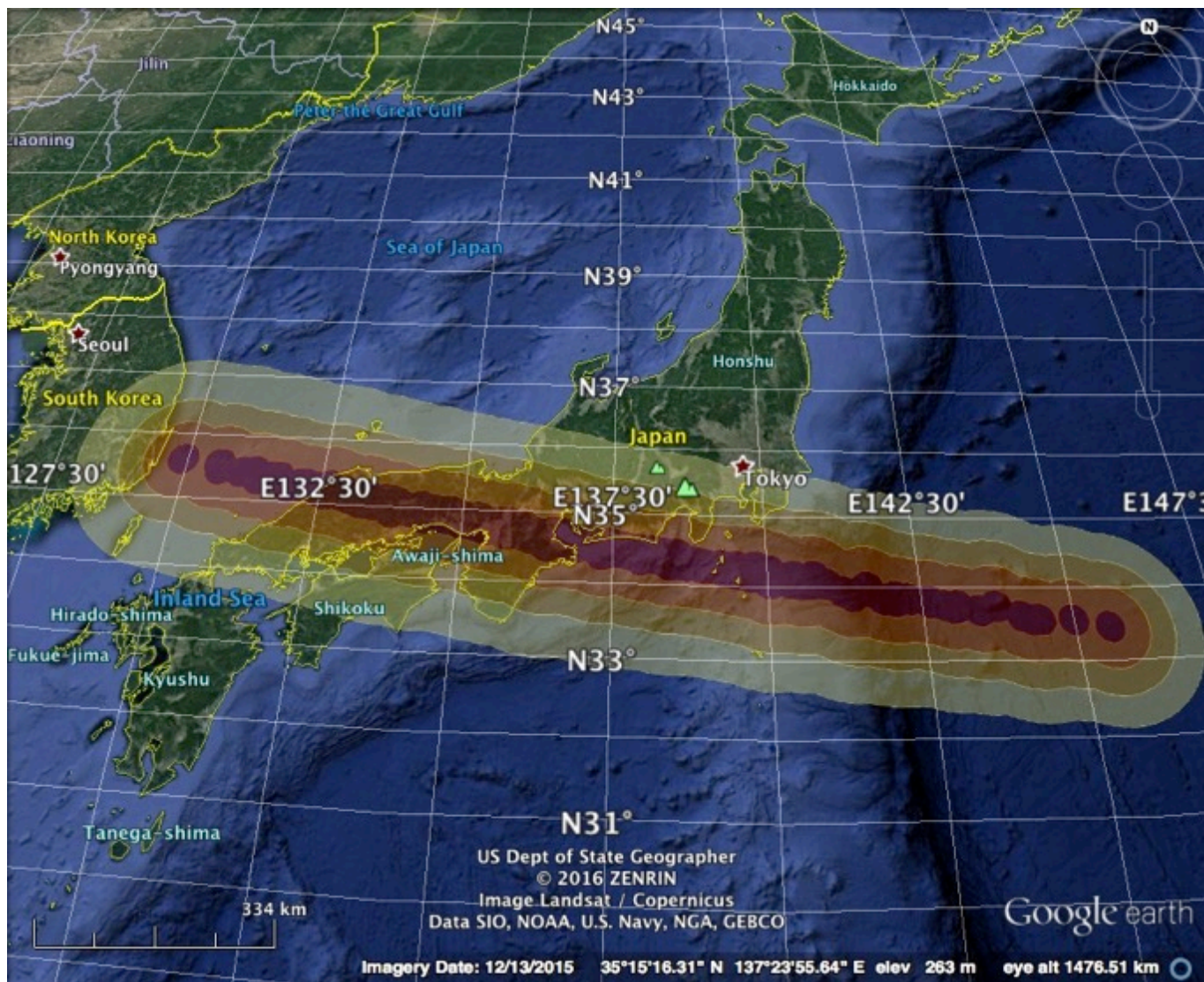
**Density Distribution, Inject 3 (s08)**



**Impact Energy Distribution, Inject 3 (s08)**

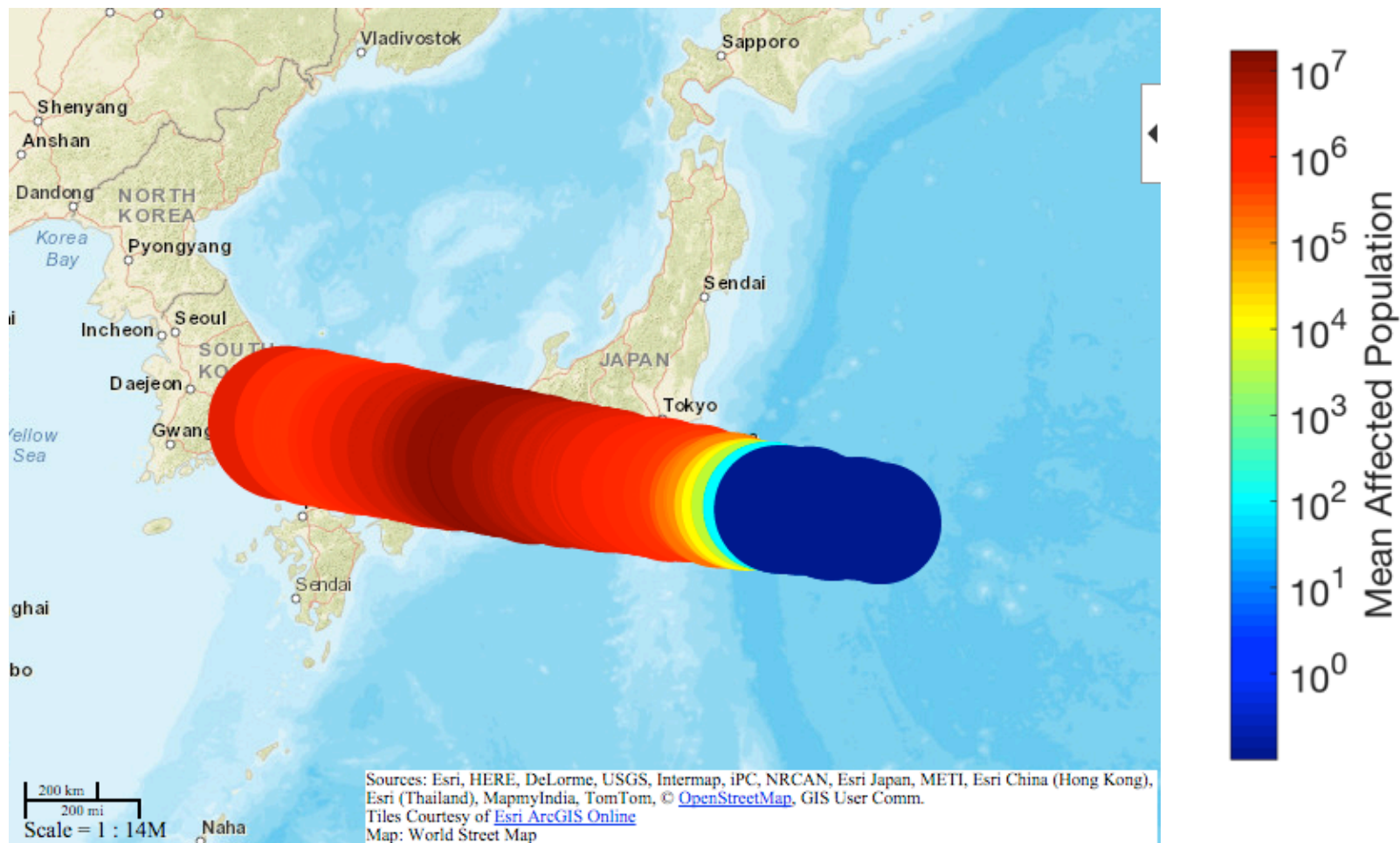


# Blast Damage Zones



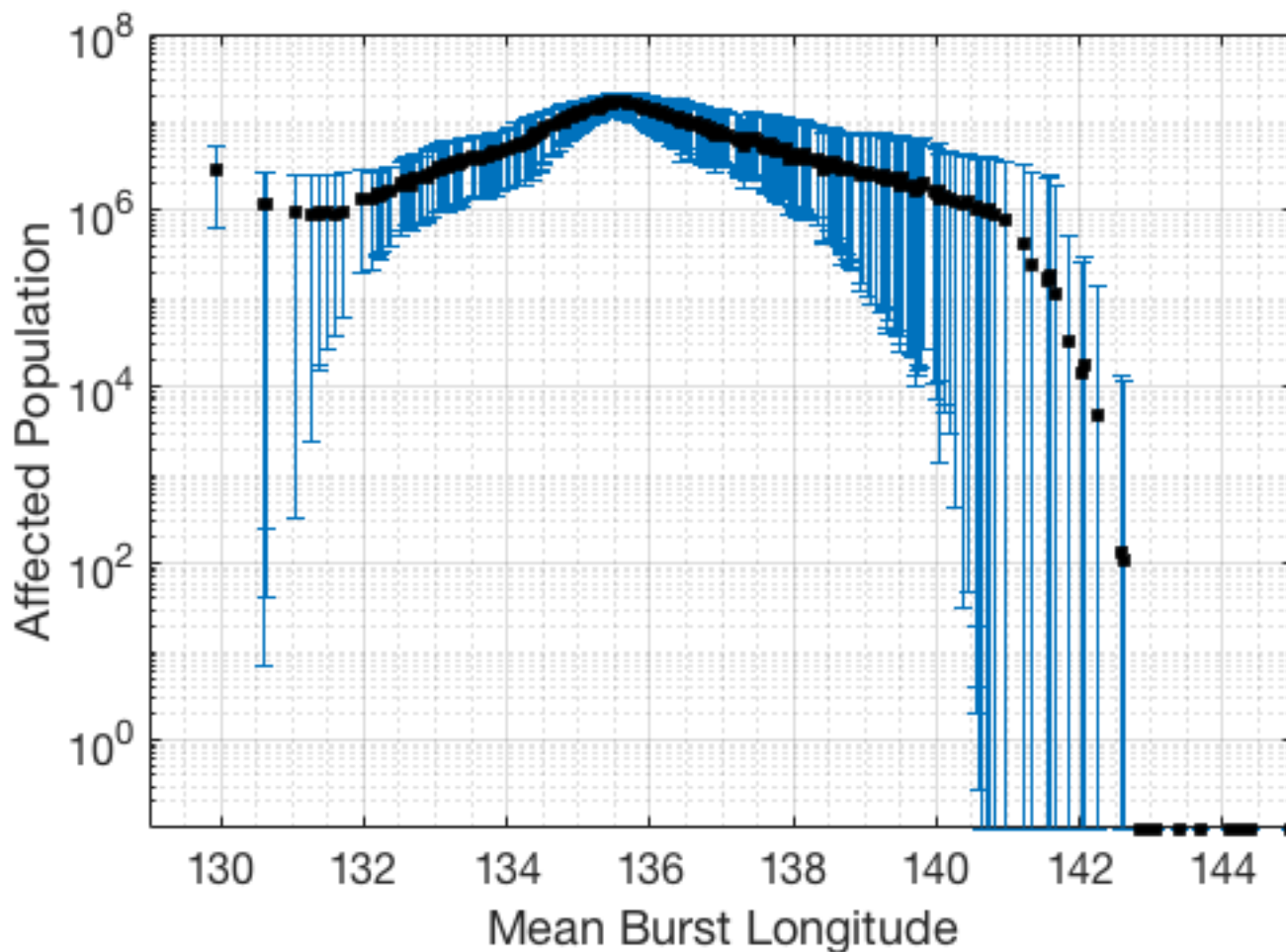


# Mean Affected Population



# Damage Ranges (min/mean/max)

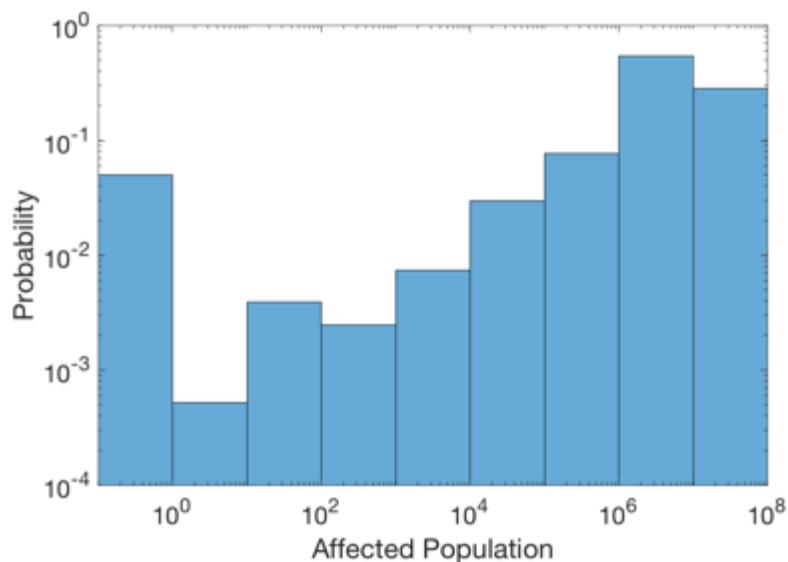
Damage Ranges Along Swath  
PDC17 5/20/2020



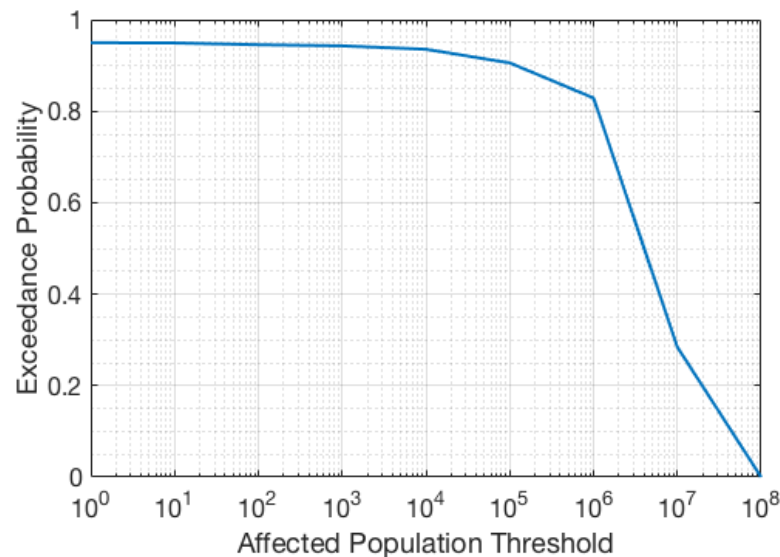


# Damage Level Probabilities

**Total Impact Damage Risk**  
PDC17 5/20/2020, 100% Impact Probability

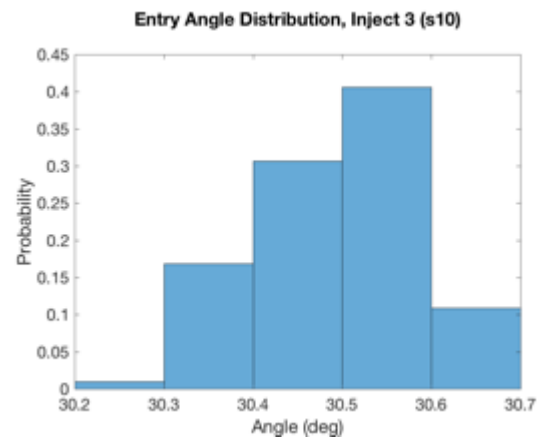
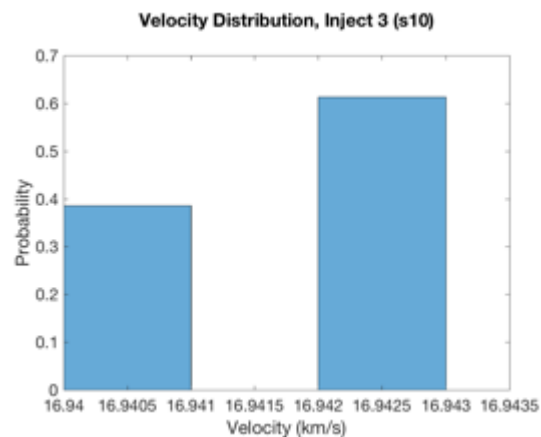
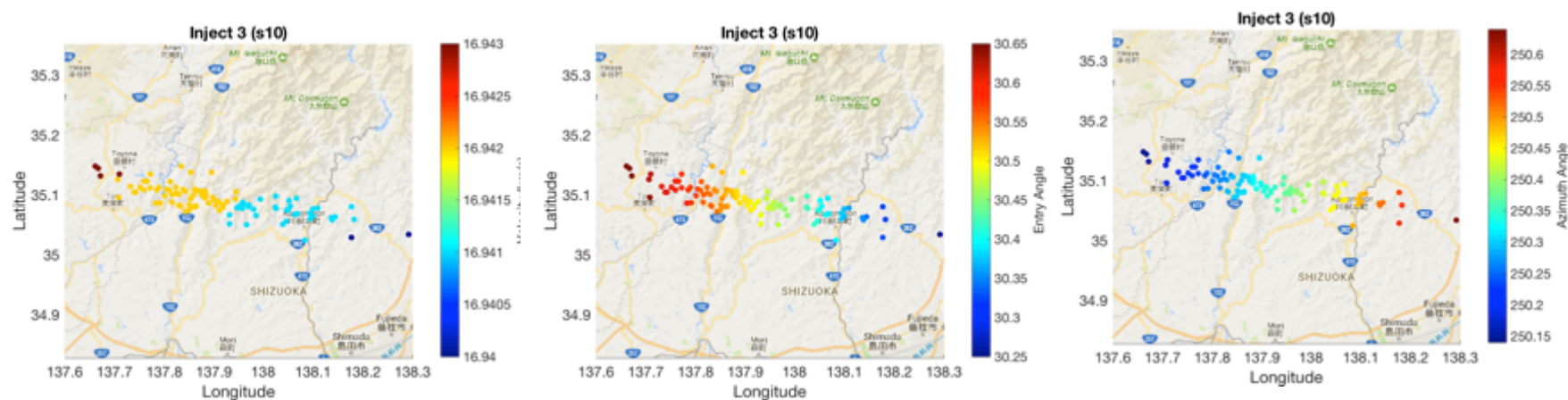


**Damage Exceedance Probabilities**  
PDC17 5/20/2020

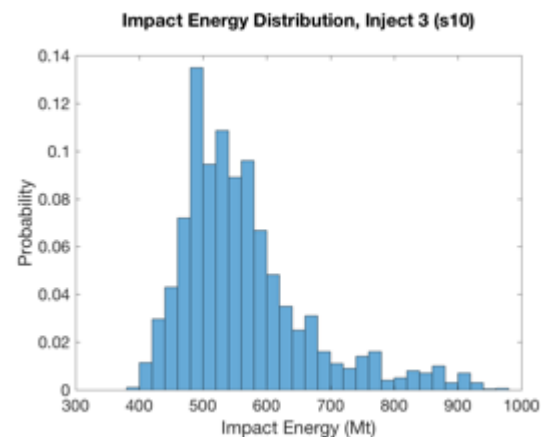
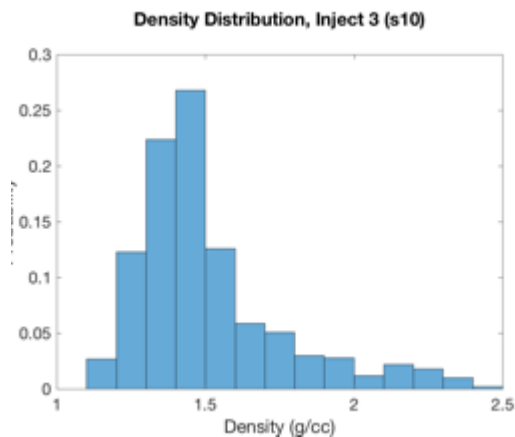
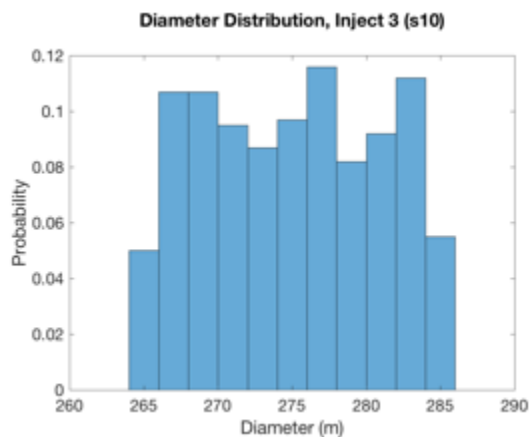


# INJECT 3 S10: MAY 20, 2020

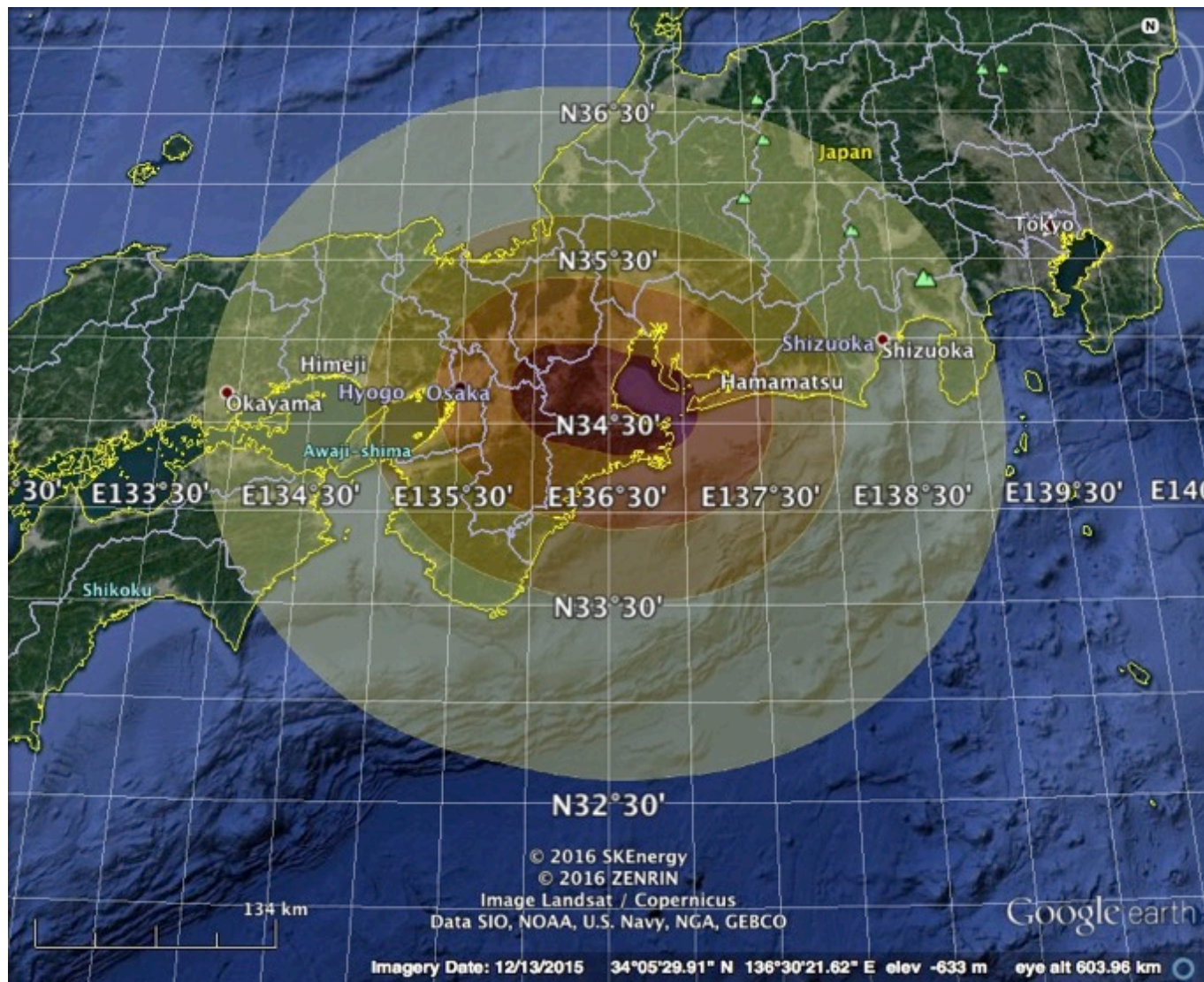
# Swath Trajectory Parameters



# Asteroid Parameter Distributions

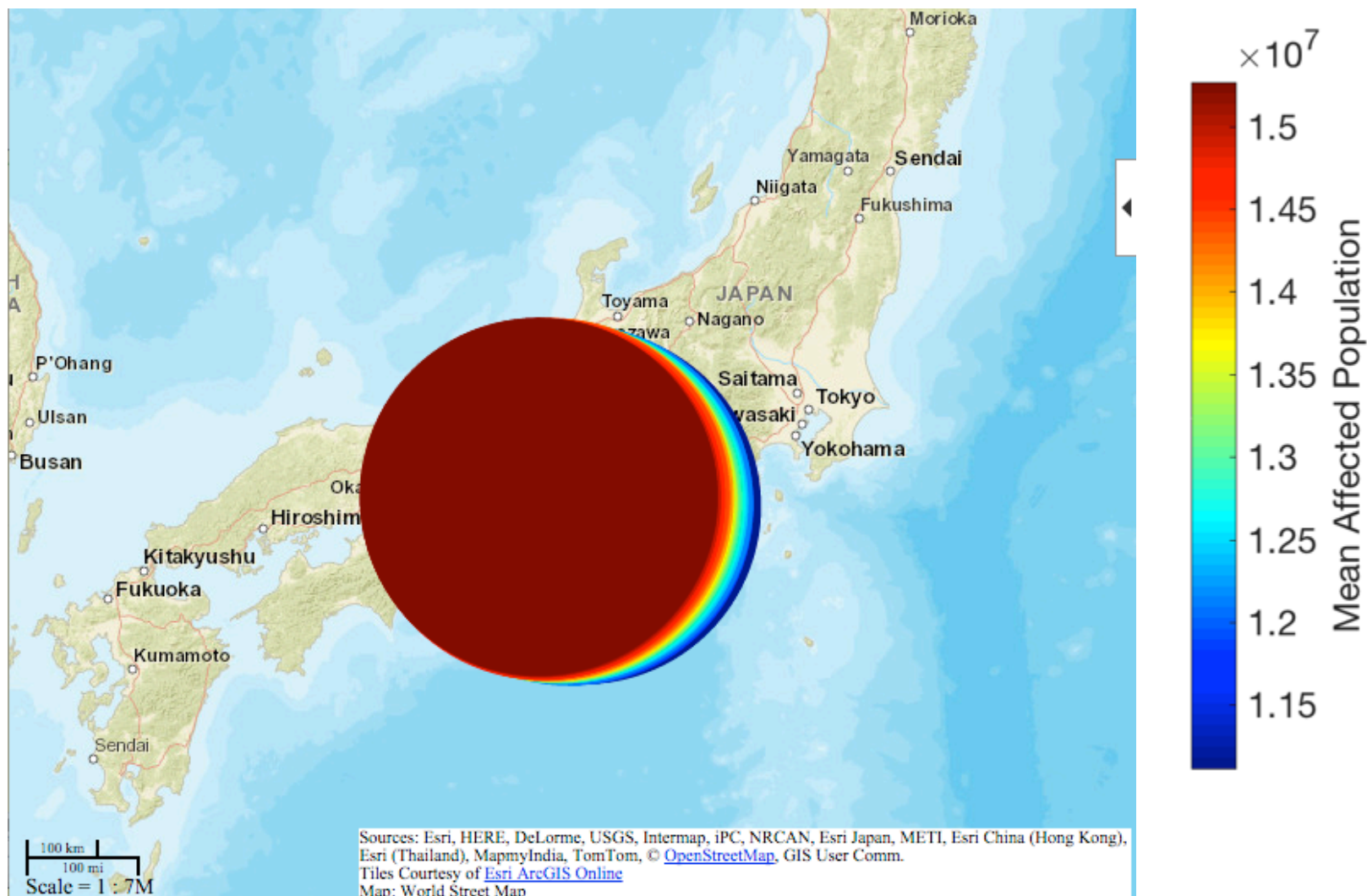


# Blast Damage Zones





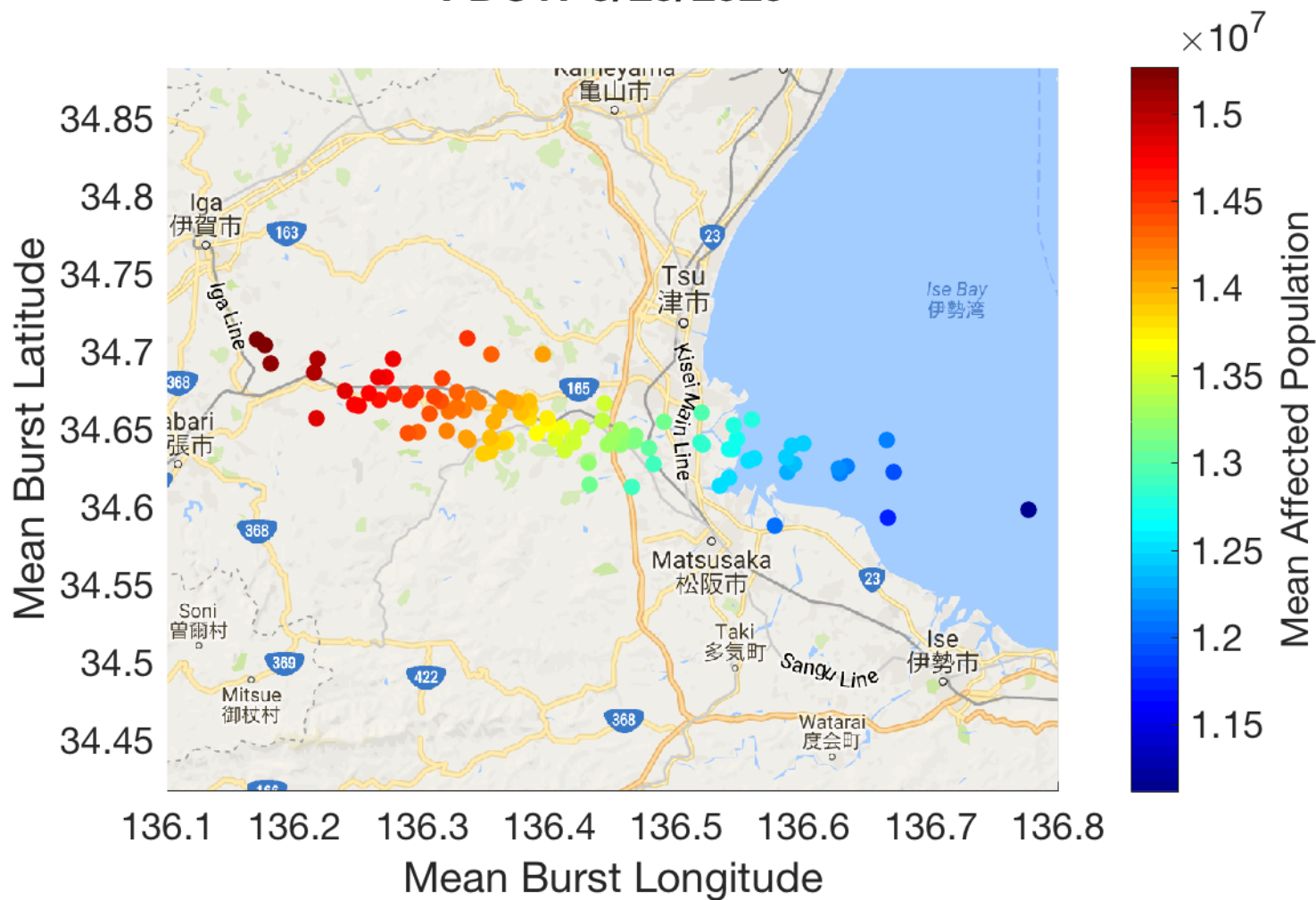
# Mean Affected Population





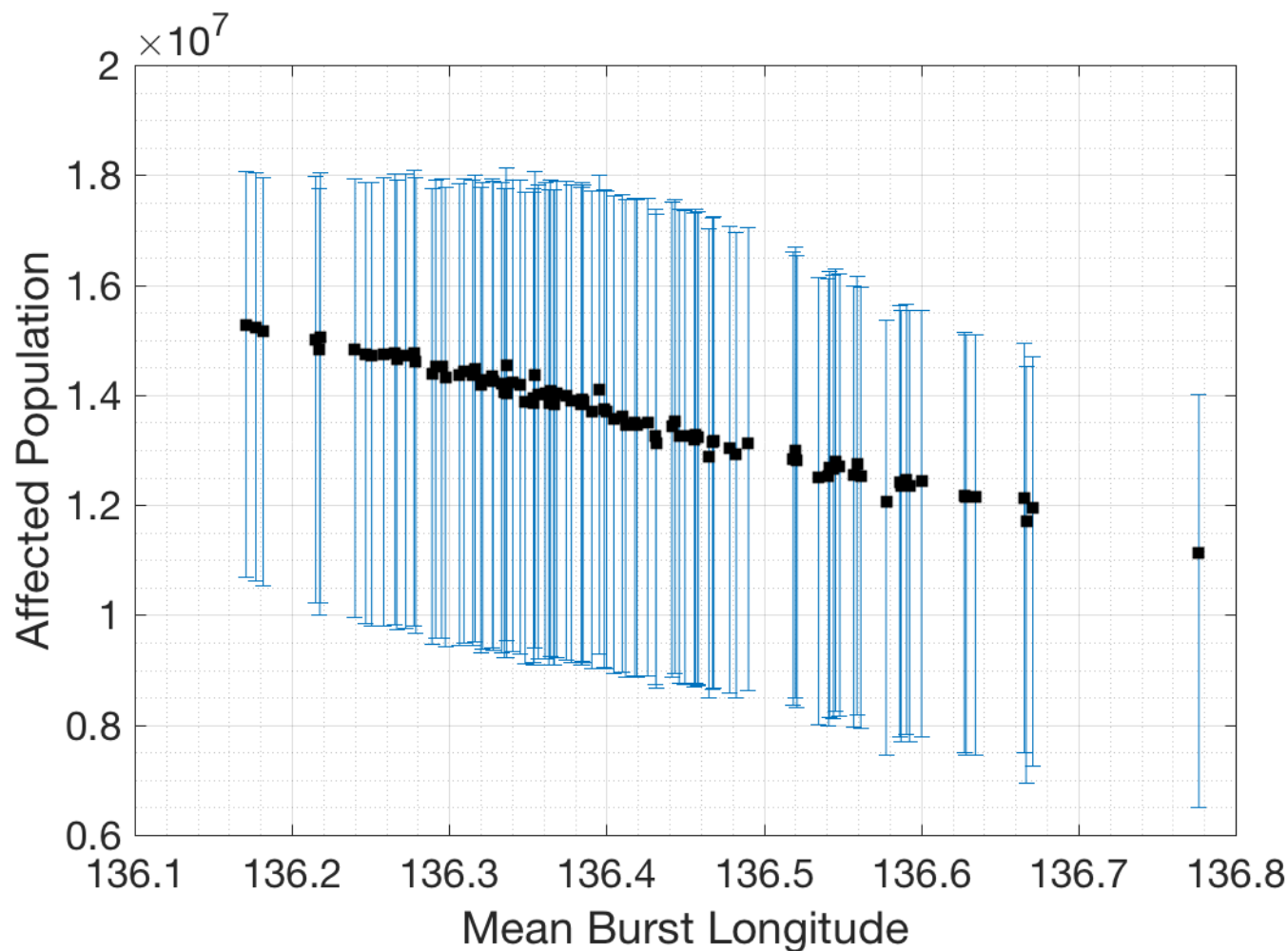
# Mean Affected Population

Mean Damage Along Swath  
PDC17 5/20/2020



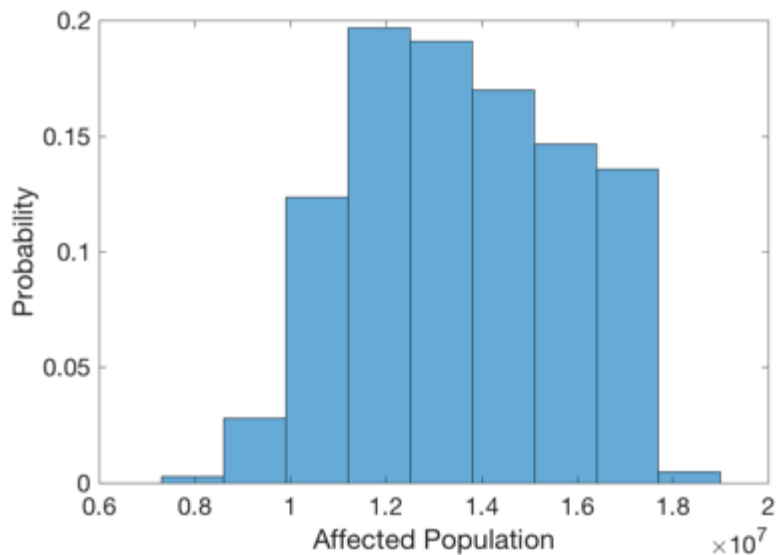
# Damage Ranges (min/mean/max)

Damage Ranges Along Swath  
PDC17 5/20/2020

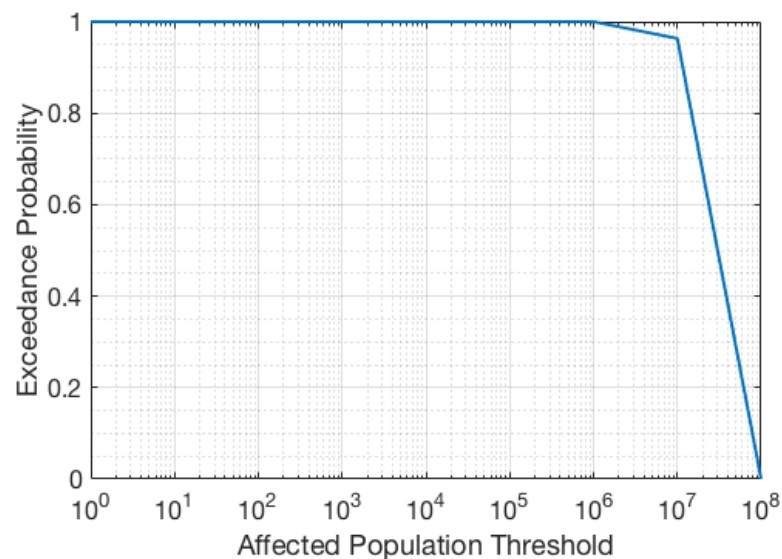


# Damage Level Probabilities

**Total Impact Damage Risk**  
PDC17 5/20/2020, 100% Impact Probability

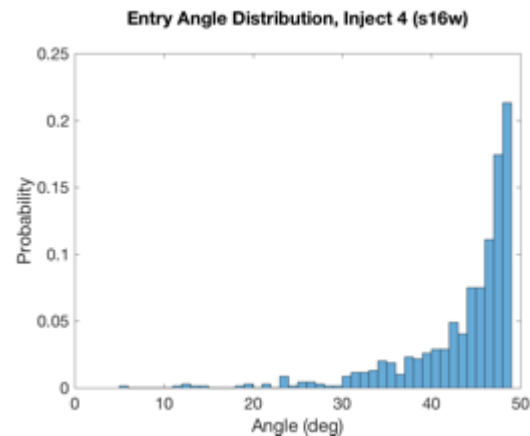
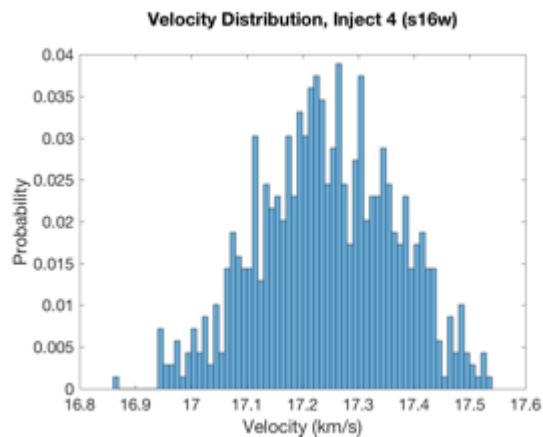
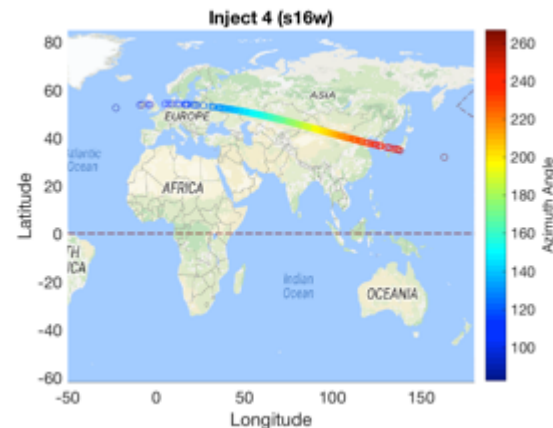
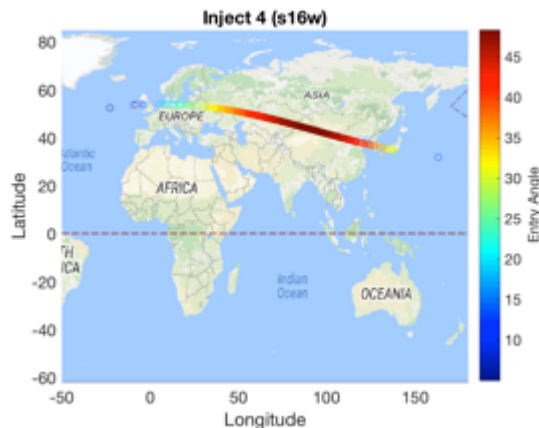
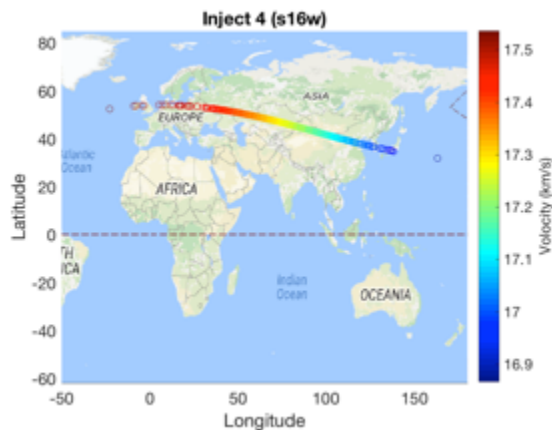


**Damage Exceedance Probabilities**  
PDC17 5/20/2020



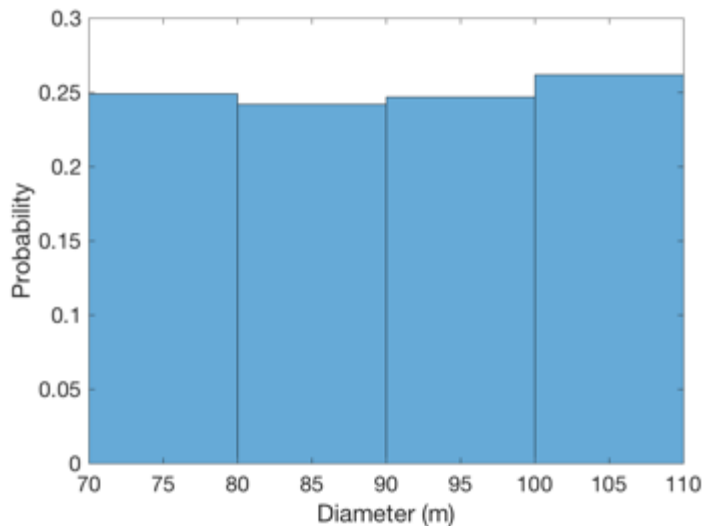
# INJECT 4 S16W: FEB 25, 2024

# Swath Trajectory Parameters

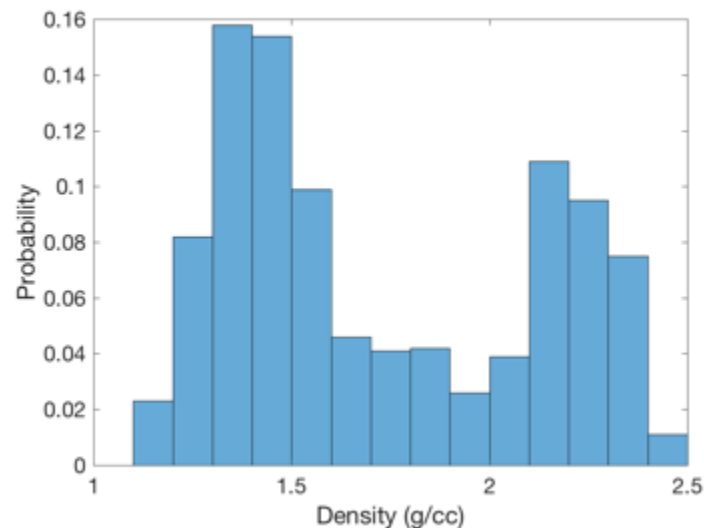


# Asteroid Parameter Distributions

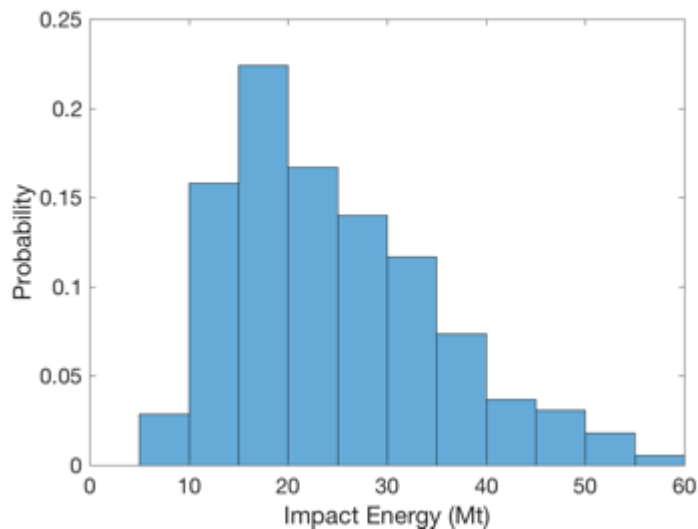
**Diameter Distribution, Inject 4 (s16w)**



**Density Distribution, Inject 4 (s16w)**

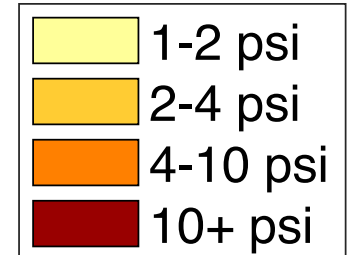
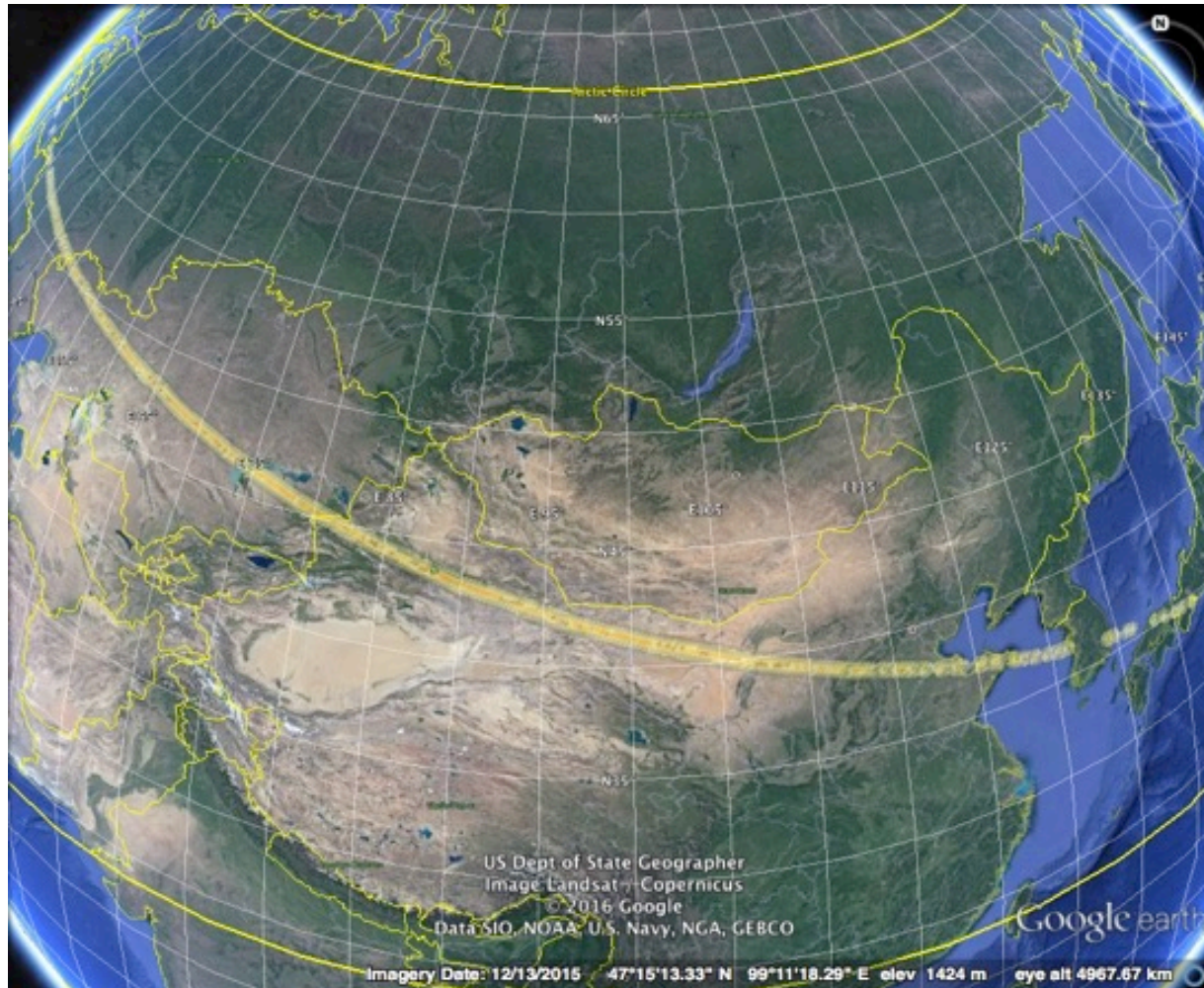


**Impact Energy Distribution, Inject 4 (s16w)**





# Blast Damage Zones

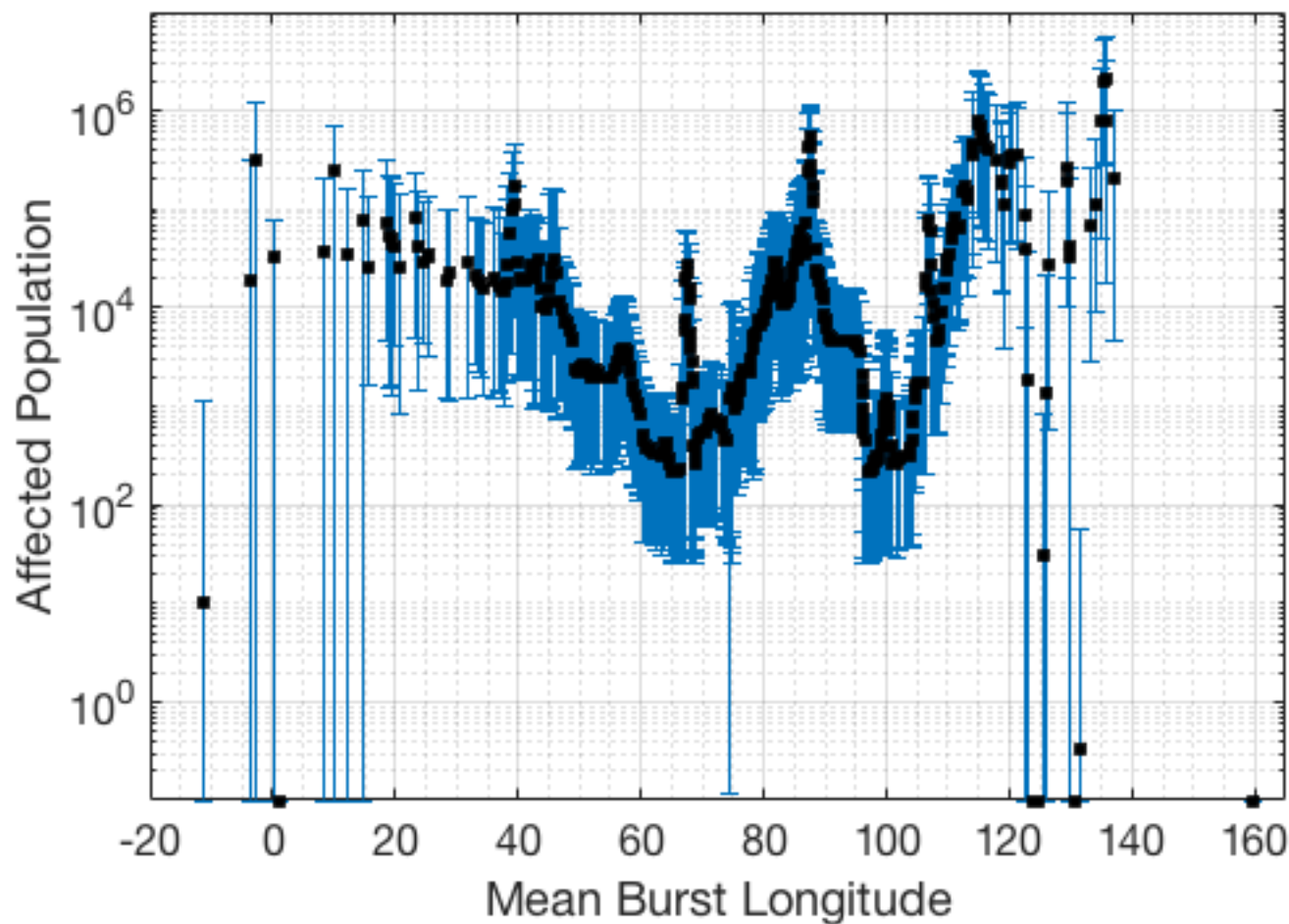


# Mean Affected Population



# Damage Ranges (min/mean/max)

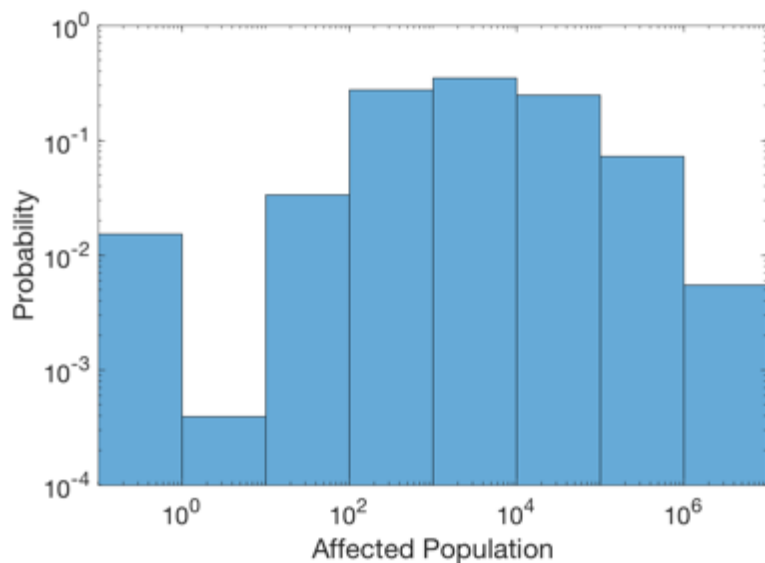
Damage Ranges Along Swath  
PDC17 2/25/2024



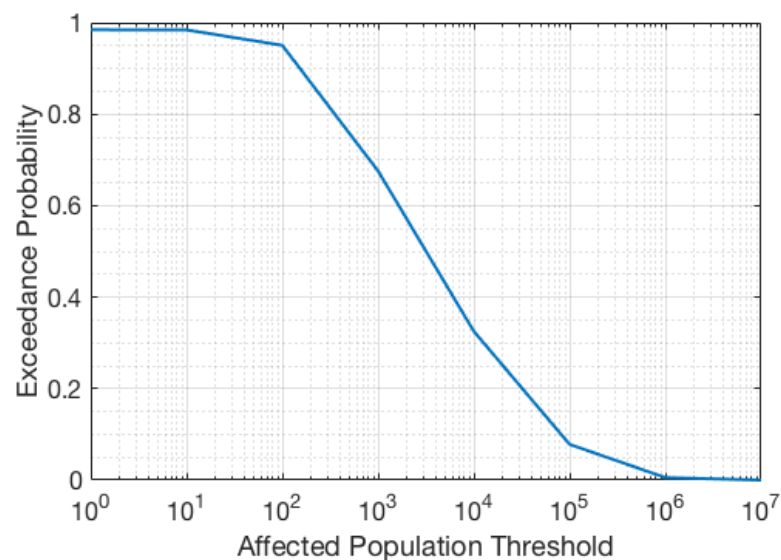


# Damage Level Probabilities

**Total Impact Damage Risk**  
PDC17 2/25/2024, 100% Impact Probability



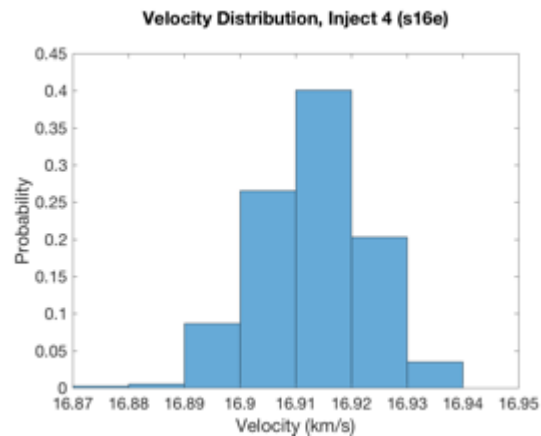
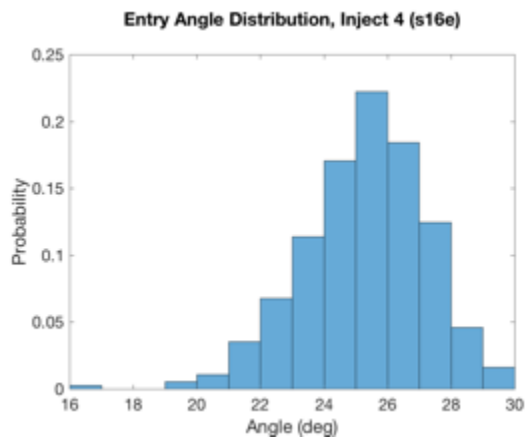
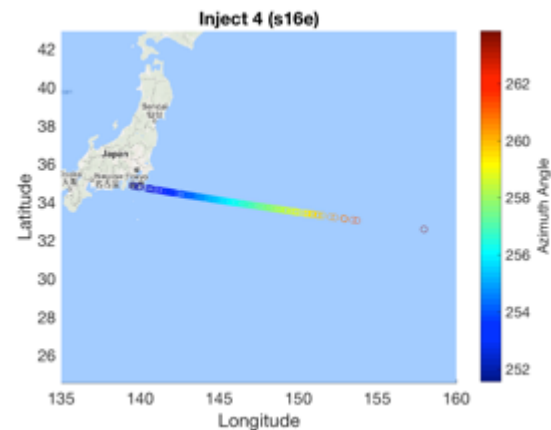
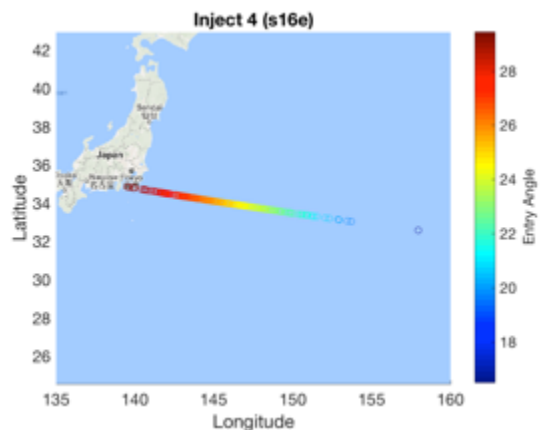
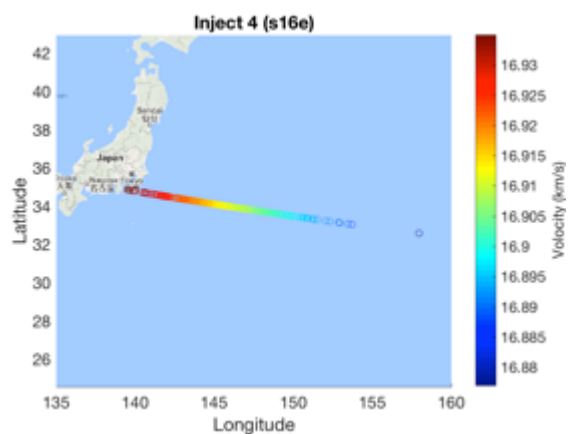
**Damage Exceedance Probabilities**  
PDC17 2/25/2024, 100% Impact Probability



# INJECT 4 S16E: FEB 25, 2024

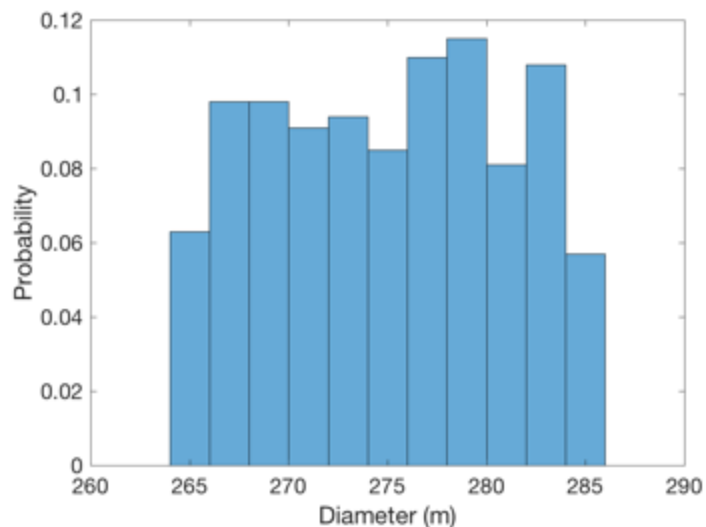


# Swath Trajectory Parameters

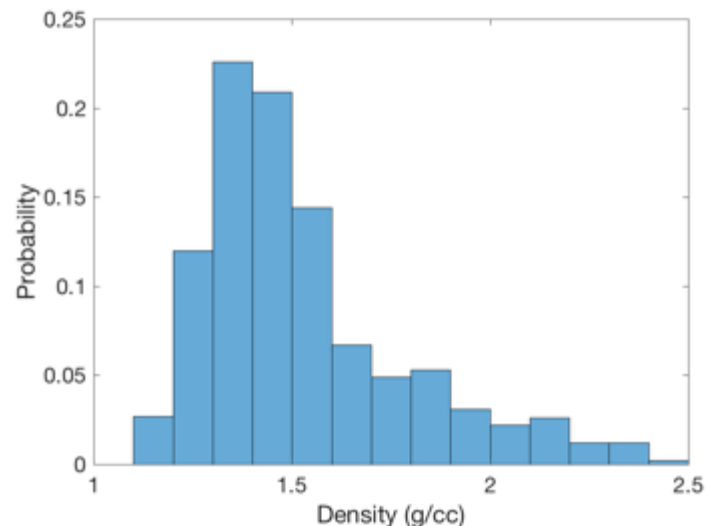


# Asteroid Parameter Distributions

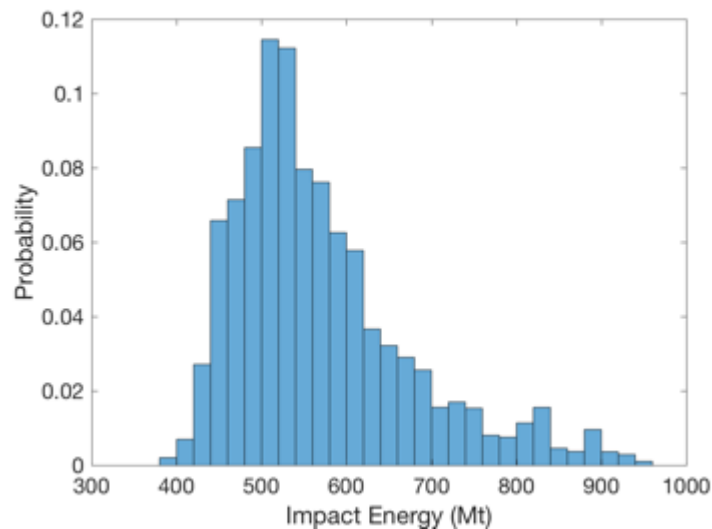
Diameter Distribution, Inject 4 (s16e)



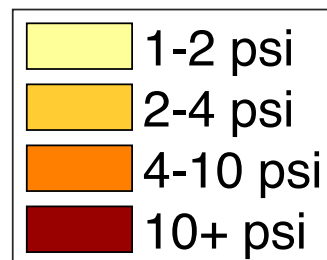
Density Distribution, Inject 4 (s16e)



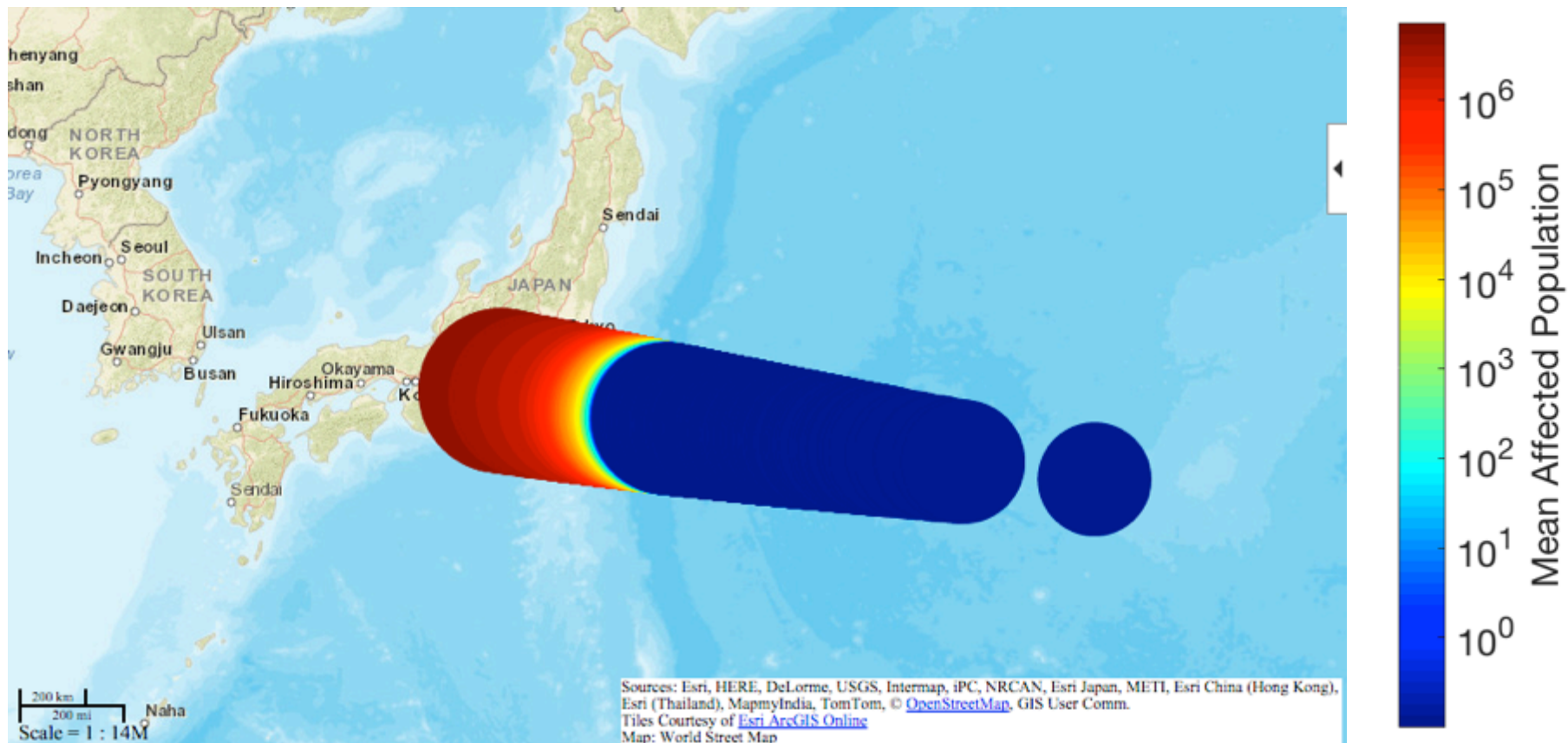
Impact Energy Distribution, Inject 4 (s16e)



# Blast Damage Zones

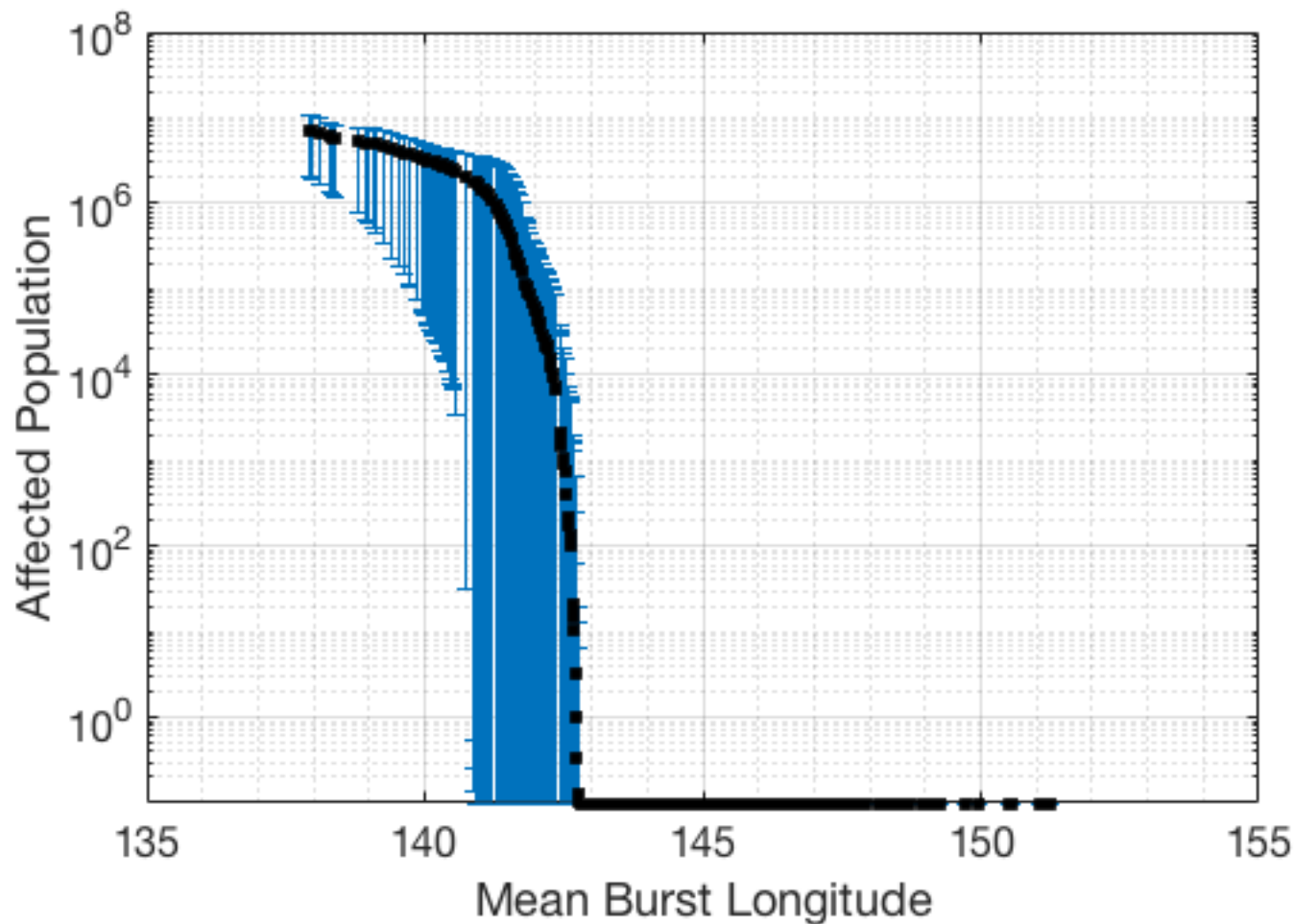


# Mean Affected Population



# Damage Ranges (min/mean/max)

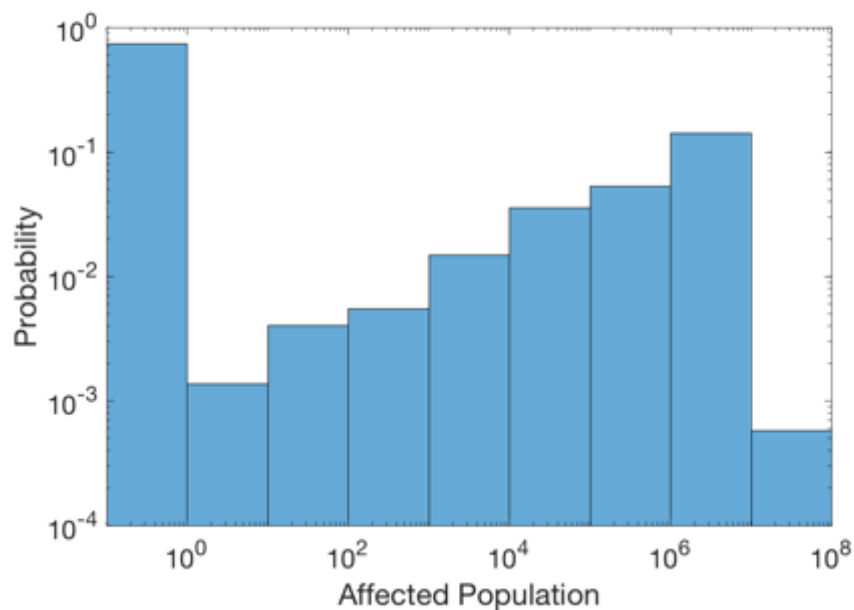
Damage Ranges Along Swath  
PDC17 2/25/2024



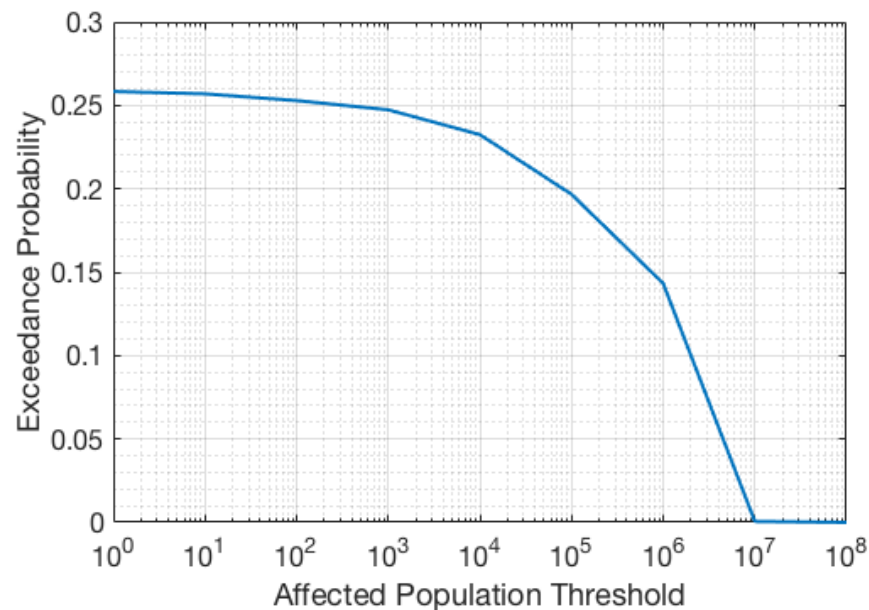


# Damage Level Probabilities

**Total Impact Damage Risk**  
PDC17 2/25/2024, 100% Impact Probability

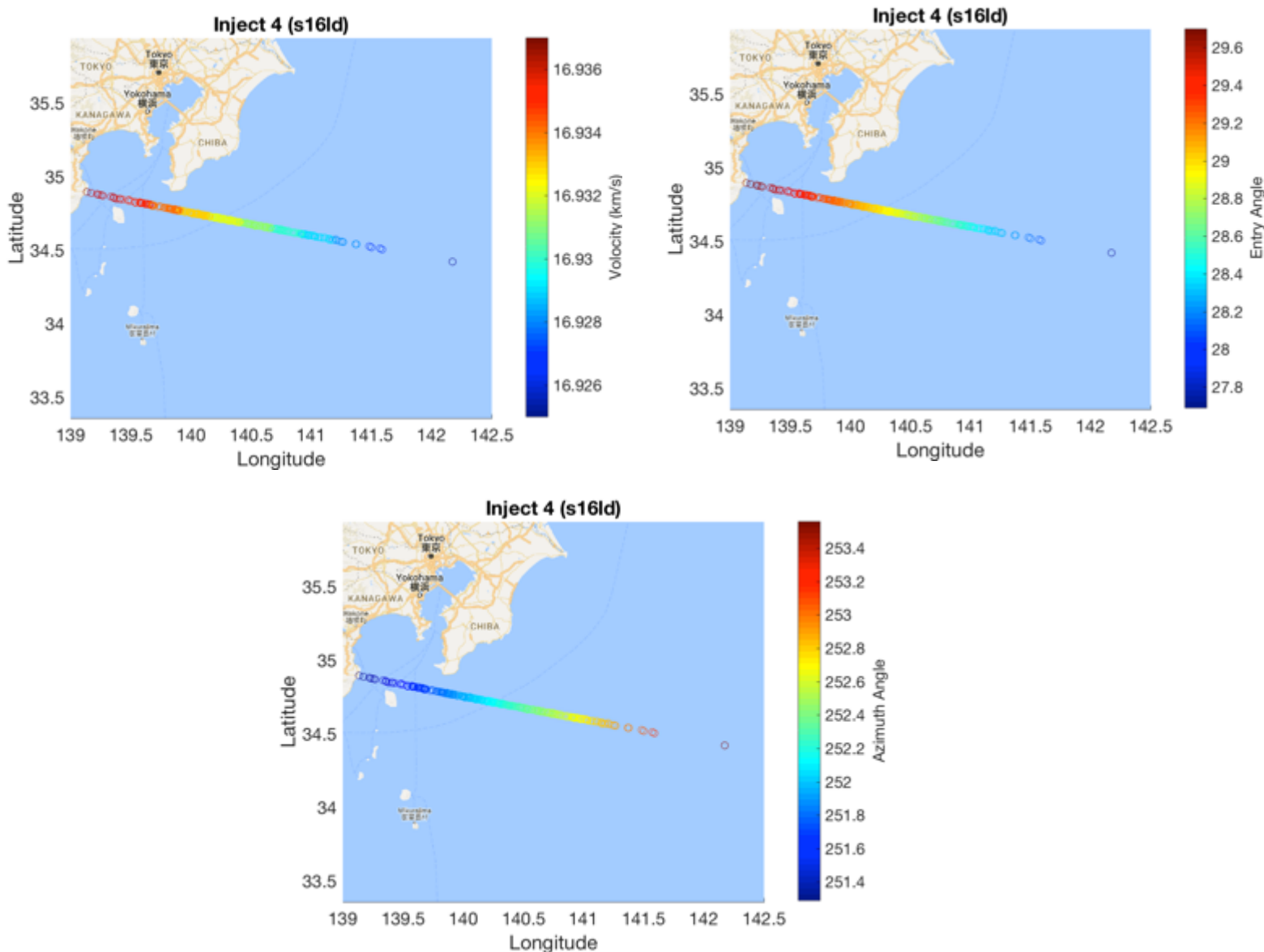


**Damage Exceedance Probabilities**  
PDC17 2/25/2024



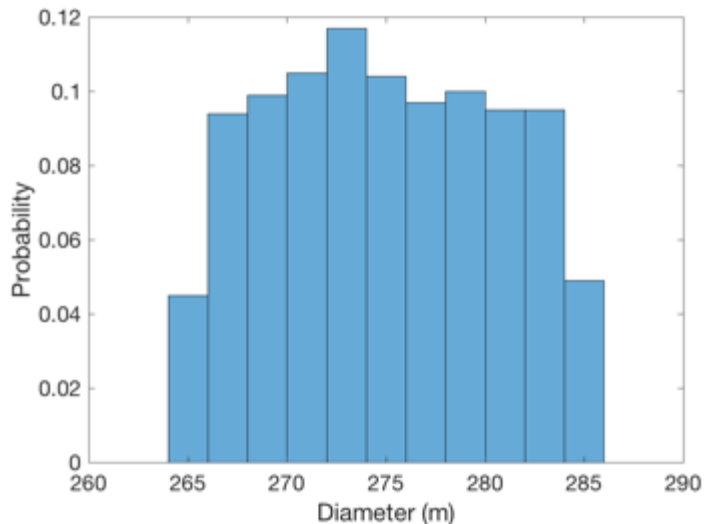
# INJECT 4 S16LD: FEB 25, 2024

# Swath Trajectory Parameters

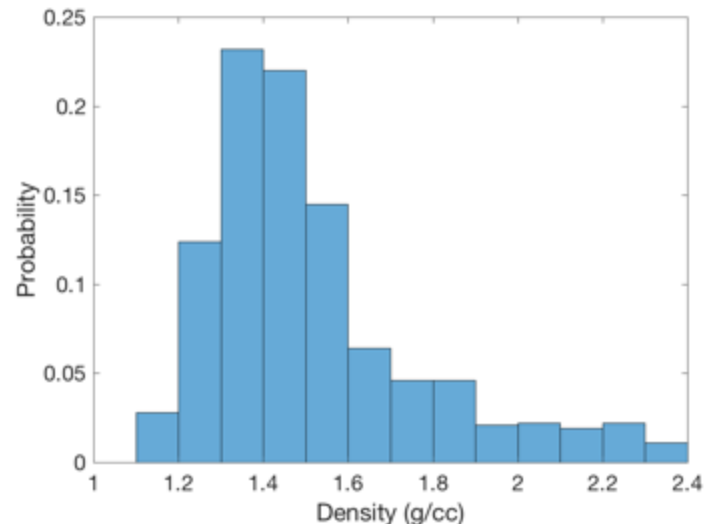


# Asteroid Parameter Distributions

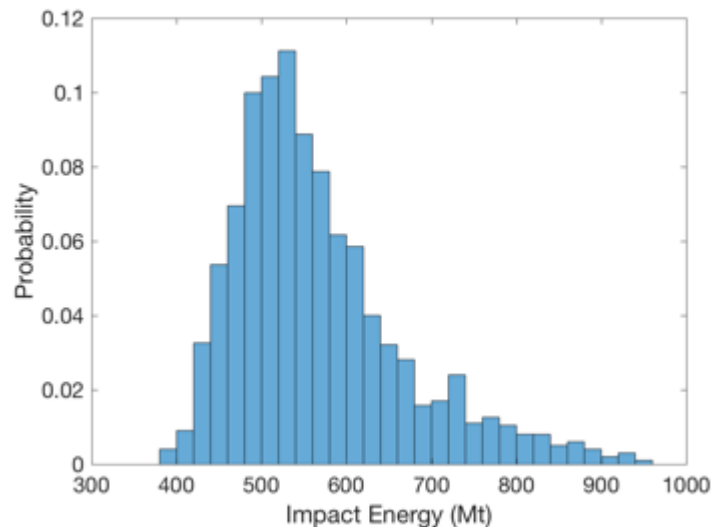
**Diameter Distribution, Inject 4 (s16ld)**



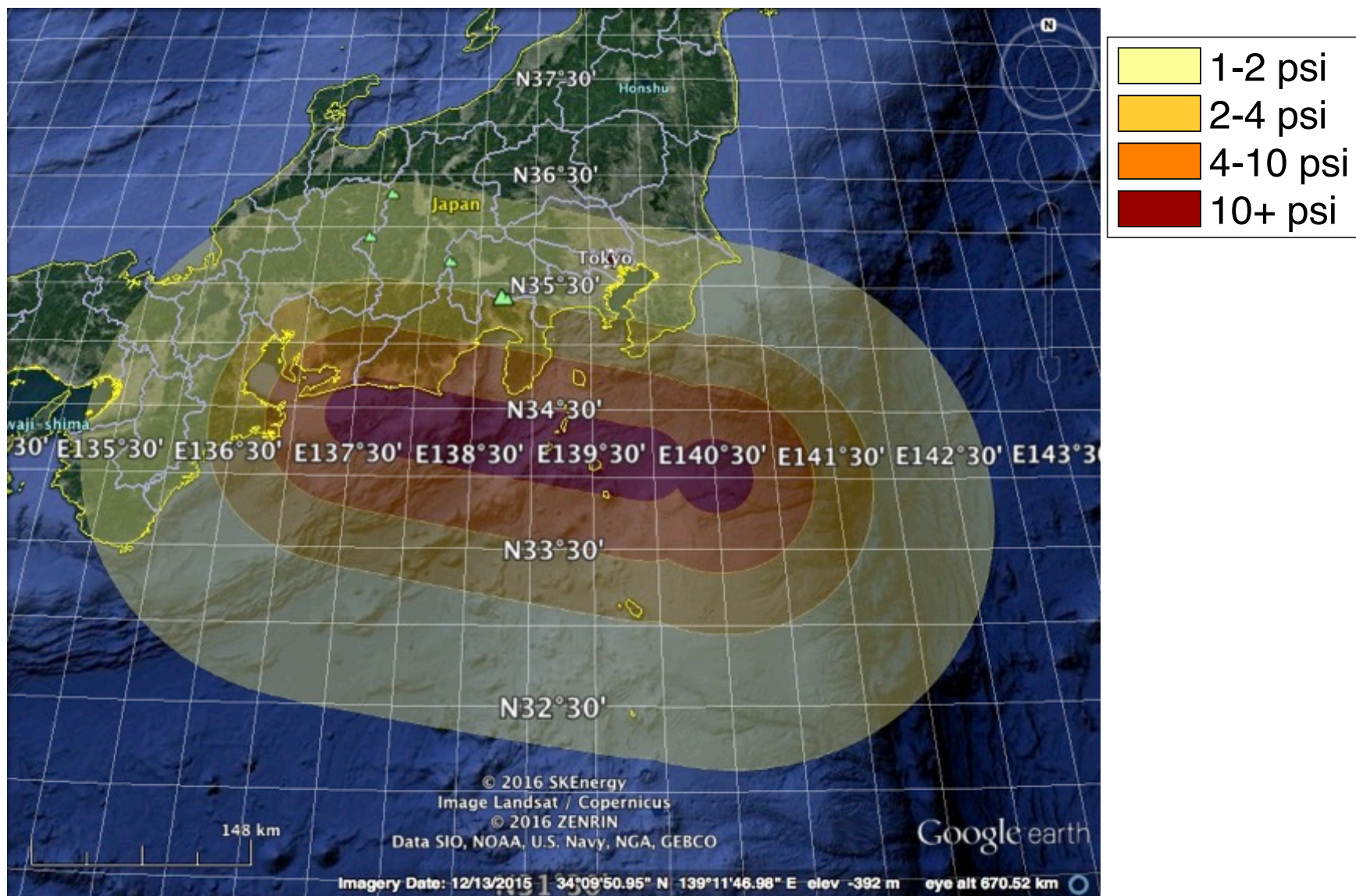
**Density Distribution, Inject 4 (s16ld)**



**Impact Energy Distribution, Inject 4 (s16ld)**

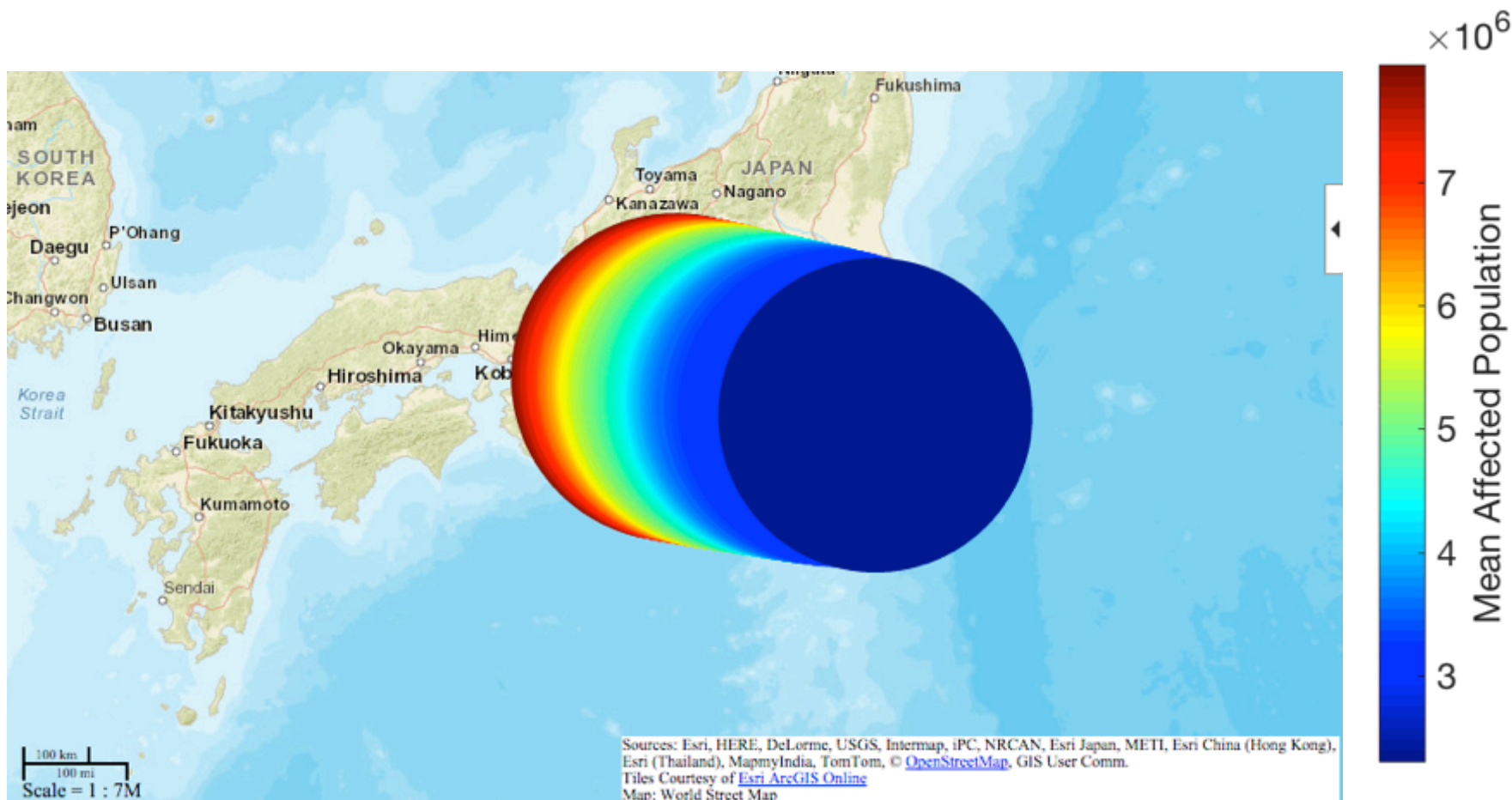


# Blast Damage Zones



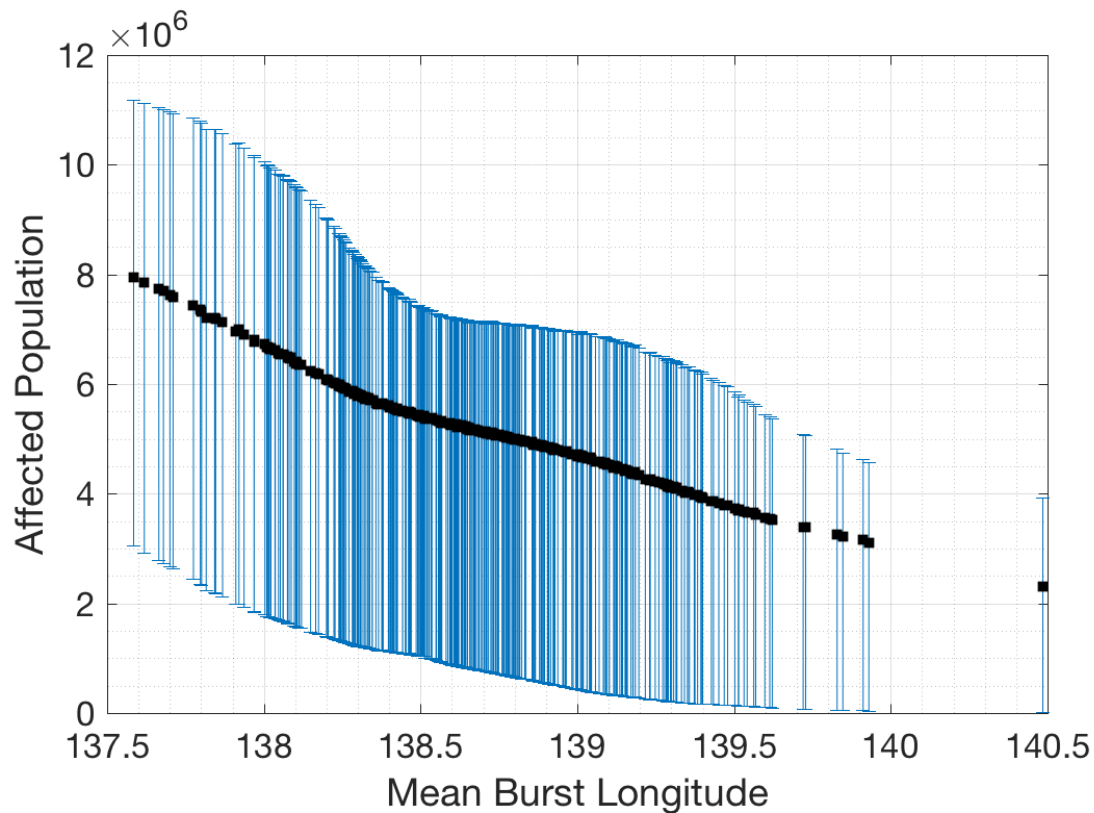


# Mean Affected Population



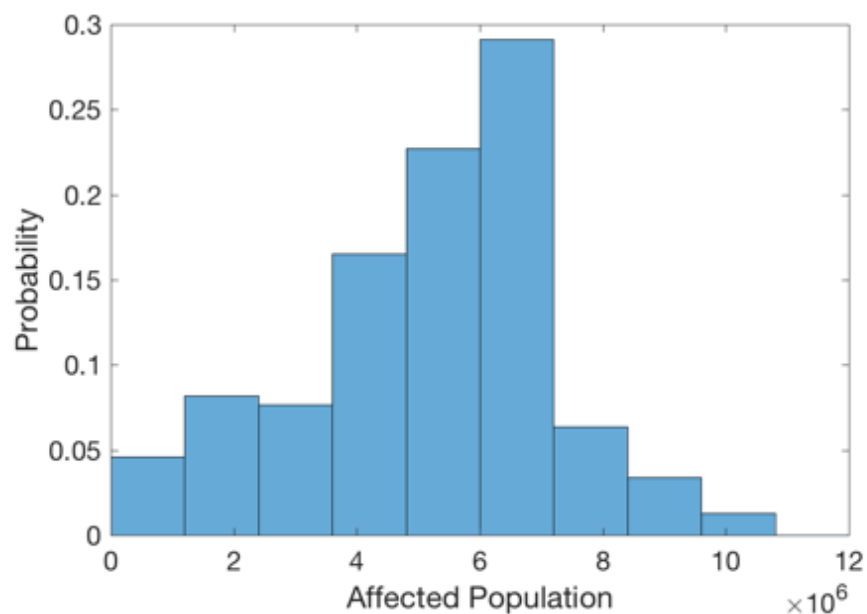
# Damage Ranges (min/mean/max)

Damage Ranges Along Swath  
PDC17 2/25/2024



# Damage Level Probabilities

**Total Impact Damage Risk**  
PDC17 2/25/2024, 100% Impact Probability



**Damage Exceedance Probabilities**  
PDC17 2/25/2024

